REPORT

OF A

SURVEY OF TRANSPORTATION

ON THE

STATE HIGHWAY SYSTEM

OF

CONNECTICUT

By

THE BUREAU OF PUBLIC ROADS
U. S. DEPARTMENT OF AGRICULTURE
AND
THE CONNECTICUT STATE HIGHWAY DEPARTMENT

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TABLE OF CONTENTS

	Page
The Connecticut highway transportation survey (introduction)	5
The development of State control of highways	9
State-aid and trunk-line highways	9
Bridges	12
The regulation and taxation of motor vehicles	13
Registration fees	14
Gasoline tax	15
Property tax on motor vehicles	15
Salient features of legislation	15
State highway organization	16
The State highways	19
State-aid roads	21
Trunk-line highways	21
State highway expenditures	26
State and town expenditures and receipts	27
Résumé of State highway activity to date	29
Economic changes affect road program	31
Increase in motor vehicles	35
The transportation survey	39
The methods of the survey	41
Density of highway traffic	42
Provision for dense traffic on certain highways	47
Traffic density in relation to present surfaces	48
Motor truck capacities and loading	49
Analysis of motor truck traffic on the basis of capacity of vehicles	51
Highways classified on basis of truck traffic	52
Motor truck loading practices	59
Motor truck overloading	60
Rear axle loading	62
Type of tire equipment	62
Load per inch width of rear tire	63
Appraisal of various measures of overloading	66
Highway utilization	67
The service value of the highway system	69
Connecticut and foreign motor vehicle use of the State highway system	70
The transportation of commodities by motor truck	73
Comparison of motor truck and rail tonnage	76
Forecast of highway traffic	82
Estimate of Connecticut highway traffic in 1930	84
Appendices:	
I. Types and lengths of State-aid roads by towns in the several population groups, July 1, 1923	87
II. Types and lengths of trunk-line highways by towns in the several population groups, July 1, 1923	90
III. Analysis of details of disbursements by appropriations on Connecticut State highways from 1895 to July 1, 1923	93
IV. Revenue receipts and expenditures of Connecticut by fiscal years for the 10-year period ended June 30, 1923	94
V. Population of Connecticut towns	95
VI. Distribution of motor trucks by capacity groups at survey stations	98
VII. Motor truck capacity overloads by amount of excess load	99
VIII. Motor truck gross weight overloads by amount of excess load	99
IX. Percentage of total gross weight on rear axle of motor trucks	100
X. Average loads on trucks equipped with various tire types	100
XI. Distribution of tire thickness and weight per inch of tire width, channel measurement, on rear tires of motor trucks	101

THE CONNECTICUT HIGHWAY TRANSPORTATION SURVEY

CONNECTICUT was one of the first States in the Union to recognize the necessity for active participation by the State government in the improvement of the main highways. Its highway department was created in 1895, just four years after the establishment of the first State highway department, in New Jersey.

As in many of the other States, the early participation, based upon the State-aid principle, was limited to financial and engineering assistance rendered to the towns on construction projects proposed by the towns and carried on under the immediate direction of the town officials.

Also, in common with the experience of other States, it was soon discovered that the need for a continuous and correlated improvement of the more important highways required for its fulfillment a greater degree of State initiative and control, and the State responded to this responsibility as quickly as it was recognized. As it had been one of the first to adopt the principle of State aid, so also it became one of the first to establish a definite system of connected trunk-line highways for construction and maintenance under the complete control of the State highway department. This was in 1913, and the towns have since been relieved of all responsibility for the roads then designated which with subsequent additions constituted, in 1923, a system of 1,566 miles.

Coincidently with this extension of State authority over the trunk-line highways, an increasing degree of control over the initiation and construction of the State-aid roads has also been taken over by the highway department, and recently the maintenance of such roads has been placed under the State. Consequently there is now little to distinguish the State-aid roads from the trunk-line highways with respect to the State's participation in their improvement, except that a portion of the cost of constructing the former is still paid by the local government units; and many miles of roads built under the State-aid plan have, in fact, been merged into the trunk-line system.

The activities of the highway department since its creation in 1895 are best considered as pertaining to two periods; the first or pioneering period extending from 1895 to 1912, and the second, or period of modern development, from 1913 to the present time. In the main,

the period of this report terminates at the end of the fiscal year, June 30, 1923, although statistics of a later date are occasionally included. Throughout the first period the vehicles using the highways were largely horse-drawn, and the location, alignment, grades, and surfaces of the highways constructed were determined by the needs of such traffic. The second period has been marked by a great increase in the motor-vehicle traffic and particularly by the development of motor-truck traffic, the result of which has been to impose requirements of design which can not economically be met by the types of roads built during the earlier period.

At the beginning of the latter period less than 6 miles of the State roads were improved with the more modern types of surfacing. The aggregate length of the improved roads was 924 miles, and of this mileage 272 miles was merely graded, the balance, with the exception of the 6 miles referred to, being surfaced with macadam or gravel.

By 1923 the length of the improved roads had grown to 1,780 miles, an increase of nearly 100 per cent, and the amount of improvement better than macadam had increased to more than 480 miles. This improvement has been made in the face of a constantly increasing traffic. The old roads have been widened and strengthened, maintained to the limit of their serviceable life, and replaced as rapidly as possible with more adequate surfaces. The earlier investment has been salvaged to the fullest degree possible, and there are few, if any, instances in which it appears that the type of road constructed has been superior to the need. On the contrary it may be said that an effort has been made to prolong the service of the old roads beyond their economic life with consequent heavy expense. Yet the limited funds at the disposal of the department at all times have doubtless permitted no other course. The same limitation is responsible for the fact that there remain on some of the most important roads sections of considerable length in the aggregate which are entirely inadequate for the present traffic.

The fact that the work of improvement was begun during the days of horse-drawn traffic perhaps accounts in large measure for the crooked alignment of many of the roads, though the inadequacy of the revenue, especially during the earlier years, may also have contributed to this condition. But, whatever the cause, it is apparent that the modern fast-moving traffic will necessitate radical changes in the alignment of many of the roads; and the expense of such changes will now be much greater than it would have been formerly.

As a result of the imposition of the gasoline tax in 1921, and the increase in license fees in the same year, the revenues obtained from those sources now constitute a fund sufficient to cover more than 70 per cent of the current gross highway expenditure of the State and over 90 per cent of the net expenditure after deduction of the refunds paid by the towns. There are few States in which the tax payment per vehicle is as great and few, therefore, in which the motor vehicle owners may more justly lay claim to adequate highway service.

To supply such service the highway commissioner estimates that it will be necessary to rebuild nearly 1,300 miles of the State system by 1930. As only 563 miles have been reconstructed during the entire period since 1913, it is evident that the State highway budget must be greatly increased to do the work planned.

The State is now confronted with a situation in which it is necessary to augment the funds at its disposal in order to provide for essential reconstruction of existing roads, and it is a question whether they can be further increased without encountering serious resistance. Certainly the motorists can not be counted upon to raise more than a small portion of the additional funds required. Yet, unless funds are made available from some source to complete the program outlined by the highway commissioner, the maintenance of the existing roads will quickly become an even greater burden.

Anticipating the need for such a program of reconstruction and development, and realizing the necessity of having as a basis for the plan accurate data with respect to the traffic on the various sections of the State highway system, the highway commissioner entered into an agreement with the United States Bureau of Public Roads to conduct cooperatively with that bureau a survey of transportation on roads of the State.

The results of the survey show that the most important highways in the State, listed in the order of the amount of highway service rendered, are as follows: (1) The Boston Post Road, from the New York line through Bridgeport, Meriden, Hartford, and Thompsonville to the Massachusetts line; (2) the route from Bridgeport to Thomaston; (3) the Shore Road from New Haven to Westerly; (4) the route from New London to Putnam; (5) the road from Hartford through Farmington, and Plainville to Thomaston; (6) the route from Hartford to New Britain and Plainville; (7) the New Haven-Waterbury road. The supreme importance of these roads has been established by an actual count of the traffic on all roads of the State system, which also indicates the relative importance of the other roads constituting the system.

It is brought out clearly by the survey that the roads selected in 1915 (fig. 4) to constitute the trunk-line system are, practically without exception, the most important roads of the State as traffic carriers. But the improvement of these roads up to this time has not been entirely consistent with the traffic they carry. There are sections of gravel and other inadequate surfacing on the most heavily traveled highways in the State.

The Boston Post Road Between New York and Massachusetts Lines is the Most Important Highway in the State

The amount of traffic observed on the various roads during the survey has been used as the basis for an estimate of the traffic on the same roads in 1930, applying for this purpose, the relation observed in other States between the increase in traffic and in the ratio of population to motor vehicle registration. In 1924 there were 6.92 persons in the State for each registered motor vehicle. Extending the past trend of this ratio to 1930 it is estimated that there will then be 3.25 persons per vehicle and on this basis the registration of 1930 is estimated at 513,000 motor vehicles, a registration more than twice as great as that of 1924. As motor vehicle traffic has been found to be practically in direct proportion to the motor vehicle registration, it may therefore be assumed that the traffic of 1930 will be at least twice as great as that of 1924. This estimate may be taken as a reliable guide in the planning of the highway program for the next five years.

On the basis of the traffic observed during the course of the survey, it is estimated that the 1,114 miles of improved highways on the trunk-line system in 1923 provided highway service

for a traffic approximating 414,000,000 vehicle-miles, of which 59,700,000 were truck-miles and 354,300,000 were passenger-car-miles. The value of the highway service rendered to this traffic is conservatively estimated at $5,334,000, which is equivalent to 23 per cent of the replacement value of the improved sections of the trunk-line system. It therefore appears that the highway service rendered by these roads is of sufficient value to pay for them in a little over four years.

INFORMATION OBTAINED FROM THE SURVEY INCLUDES COMPLETE DATA WITH REGARD TO THE TRAFFIC ON THE HIGHWAYS

Other information obtained from the survey includes data with regard to the character of the traffic on the highways; the relative proportions of passenger-vehicle and motor-truck traffic; the classification of the motor trucks on the basis of capacity; and the length of haul by truck, on the basis of which it is determined that truck haulage is in the main a short-haul operation. The intensive study of motor-truck loading practices, based upon the actual weighing of thousands of trucks, should serve as a sound basis for the regulation of these vehicles to protect the roads and minimize the cost of repair.

The importance of the motor-truck traffic and of the highway service rendered to that traffic is clearly apparent from the survey. It is shown that a considerable part of the total package-freight movement between origins and destinations in Connecticut less than 50 miles apart is transported over the highways. As distance between origin and destination increases, the motor-truck transportation becomes of less importance. Regular and rapid transportation service between wholesale distribution points and the retail markets has made possible a regular supply of perishable foodstuffs in these markets and thus increased the effective demand for such commodities. It has also enabled the retailer to do business with a smaller stock of goods, reducing thereby the necessary capital investment.

The transportation survey was conducted under the general supervision of Thomas H. MacDonald, chief of the Bureau of Public Roads, and John A. MacDonald, highway commissioner of Connecticut. J. Gordon McKay, chief of the division of highway transport and economics, and A. B. Fletcher, consulting highway engineer of the Bureau of Public Roads, directed the work of the survey with the advice and assistance of George E. Hamlin, superintendent of maintenance, Connecticut Highway Department.

THE DEVELOPMENT OF STATE CONTROL OF HIGHWAYS

AS IN the other Colonial States the records of early highways in Connecticut are very meager, but not long after the settlement of the colony there were well-defined routes of travel connecting Boston and Springfield in Massachusetts with New London, New Haven, and Hartford in Connecticut. Later many roads were built to connect with other smaller settlements as they developed.

At first the selectmen of the towns [1] had entire control of the roads. Later the county commissioners were given authority to order repairs to be made at the expense of the town if the town neglected or refused to maintain its roads properly. But with this exception the selectmen managed the roads alone until the beginning of what has been called the "turnpike era," and, as in other parts of the country, no substantial improvement was made until the beginning of that "era."

The general assembly of the State began to issue franchises to turnpike companies about 1795, and from that time until 1853 some 121 franchises covering approximately 1,740 miles of road were issued. Most of the turnpikes so authorized were built, and they were almost wholly under the control of the turnpike companies which built them. The companies made such repairs as were made and levied tolls upon the users as the means of obtaining the necessary revenues. It is an interesting fact that the mileage of these turnpikes authorized between 1795 and 1853 was very nearly the same as the total mileage of the State highway system in 1923, and that many of the present Connecticut trunk lines are not only in the same general location but occupy the identical rights-of-way upon which the old turnpikes were built.

[1] The word "town," as used in this report, refers to the political unit of the State which is somewhat similar in size to the township of other States, but differs from the township in that it is an incorporated unit. The whole area of Connecticut is composed of cities, boroughs, and towns. In 1925 there were 13 cities and 1 borough the boundaries of which were coincident with town lines. In each of these political subdivisions, however, there is a dual government. In each case there is a board of selectmen, whose duties are of a relatively minor nature. In addition to these boroughs and cities, there were 20 boroughs and 8 cities within the borders of 33 of the towns, which were really more or less independent incorporated communities. In this report, however, the word "town" includes cities and boroughs. In 1923 there were 168 separate areas commonly referred to either as cities or as towns and so designated on the maps of the State.

It was not long before it came to be generally recognized that the turnpikes were not profitable investments to the companies, and as it was notorious that repairs were being seriously neglected, provision was made by law in 1844 to permit the selectmen to make the needed repairs at the expense of the companies. This was followed in 1854 by the passage of a law which provided that the companies could turn back the roads to the towns, and as the turnpikes became town roads the selectmen again took charge of them. Thereafter, except in instances where the town placed the control of its highways under a superintendent of streets or highway commissioner, a course rather generally adopted in the large towns, the selectmen had almost exclusive control of the highways until 1895 when the State highway development began.

Thus the management of the Connecticut roads was almost wholly decentralized from the beginning until 1895, when a general improvement of the roads of the State being demanded, no way was found to bring it about except by a central State agency to manage the main-road improvement, working with State funds allotted to the towns in the form of State aid. Connecticut was one of the earliest of the States to see the merit of such a plan.

State-aid and trunk-line highways.—The first act by which the State undertook to participate in the improvement of highways was approved by the governor July 3, 1895.

A State highway commission of three members was then created to administer a scheme for the granting of State aid to the towns. To initiate the proceedings, a town meeting was required to appropriate money for the town's share of the cost of the work which the law fixed at one-third of the total cost. The county in which the town was located was also required to pay one-third of the cost and the State the remaining third.

The commissioners required a request or petition from the selectmen to the State highway commission embodying "a full description of the road to be improved, giving the location, the town and county, and the kind

of road desired, also the distance in feet or miles, naming the point from starting and also where you intend to stop." A survey of the road and specifications were required to accompany the request.

The State's share in the venture was not to exceed $75,000 per annum.

This plan was changed by the general assembly in 1897 when, by an act repealing the statute of 1895, it created a single highway commissioner in lieu of the board of three members. The new law eliminated all county participation in the cost of the State-aid roads and provided that the towns and the State should each pay one-half of the cost.

An Attractive Section of Trunk-line Highway Near Danbury

The term "public road" was defined "to mean and include only the main highways leading from one town to another"; the State's share was limited to a total of $100,000 per annum; and not more than $3,000 could be expended in "any one town in any one year."

The selectmen of a town after authority from the town meeting, and with the State highway commissioner, were to select the highway or portion thereof to be improved and to cause the necessary surveys to be made and the specifications prepared. The specifications were to be submitted to the highway commissioner and if he approved of them the selectmen were to advertise for bids for the work. They were, however, given the option to do the work themselves if they submitted a bid to the highway commissioner previously to the public opening and he found that theirs was the lowest received.

Under the new law the selectmen were required to inspect the work done under the contracts let; to require conformity to the contracts and specifications; and to file with the highway commissioner, on the completion of the work, a certificate, under oath, "that all the plans have been completed according to the contract."

In 1899, a report was made by a special committee of nine appointed by the general assembly of 1897 to investigate the subject of State road improvements. Among other statements and recommendations the committee said:

> We believe that the general welfare will be promoted by a complete system of improved, intertown highways and that the benefit to the people of these wealthier towns, upon whom will fall the larger part of the cost thereof, will recompense them for the outlay.
>
> We likewise believe that with the great advantages of good over poor roads, which are so apparent as to need no mention, it will be a matter of economy in the smaller towns to pay a small portion of the cost of good road construction rather than to continue the present system of maintaining what at best are in many cases indifferent, if not absolutely poor highways.

The committee also recommended that the State highway commissioner be instructed to inspect all highways built in part with money furnished by the State and that after notification by him as to the necessity of repairs, on the neglect of the selectmen to comply with his orders, he should cause the repairs to be made at the expense of the town.

Following this report, the general assembly of 1899 repealed the 1897 act and adopted in general the recommendations of the special committee. The new act provided for the appointment of a highway commissioner, to serve four years, who should be a capable and experienced road-builder, and fixed his salary at $3,000 per annum.

It did not change the former provision that the selectmen should cause the road surveys to be made, but the highway commissioner was authorized for the first time to appoint inspectors to pass upon work under construction.

Towns with a grand list, or taxable valuation, of over $1,000,000 were to pay one-third of the cost of the road improvements and those with a grand list of less than $1,000,000 were to pay but one-fourth, the State to pay the balance in either case.

The total cost to be paid by the State in a single year was not to exceed $175,000, and $4,500 was the maximum amount which could be spent by the State in a town in any one year.

The towns were required to keep the State-aid roads in repair subject to the approval of the highway commissioner, and on neglect of any town to make the repairs ordered by him he was given authority to do the work necessary at the expense of the town.

The inspectors appointed under the new law were generally residents of the towns where the work was in progress, and nearly always one of the board of selectmen was made the inspector.

From 1899 to 1906 there were no radical changes in the principles of the State-aid law, though there were amendments from time to time making small changes in procedure and increasing the appropriations.

In 1906, however, following the suggestion or recommendation of the highway commissioner, who for some years had been desirous of joining the more or less detached sections of State-aid roads into a trunk-line system, the trunk-line principle was recognized in the law and an appropriation of $25,000 per annum was made to begin such a system. The need for engineering skill in the road work was also beginning to be recognized, and the highway commissioner was authorized to appoint engineers, deputies, and inspectors; but not more than $15,000 per annum was to be spent for the purpose.

In the 1907 statute the final selection of the highways to be improved was left to the highway commissioner; and it was also prescribed that he was to make all surveys, plans, and specifications. The planting of shade trees could be made a part of the specifications if the selectmen deemed them necessary or desirable. Improvements to cost $1,000 or less could be authorized by the highway commissioner to be built by the towns without competition. All bids for work on contracts were to be received and opened at the commissioner's office in Hartford.

Towns with a grand list over $1,250,000 were required to pay one-quarter of the cost of the State-aid roads, while towns with a smaller grand list were to pay but one-eighth.

The highway commissioner could enter any town and extend or improve any highway which he considered necessary as a connection of the trunk-line system, and he could spend not more than $250,000 annually on such connections. He was also charged with the duty of keeping all State-aid roads in repair, the towns to reimburse the State for one-fourth of the expenditure; and for this purpose a State repair fund was established to consist of such moneys as the State might appropriate from time to time, together with the moneys received from the towns in the way of refunds.

Above: Failure of the Old Oneca Bridge
Below: The New Bridge at Oneca in the Town of Sterling

The annual appropriation for engineers, deputies, and inspectors was increased to $25,000 per annum, and it was provided that no sum in excess of $10,000 could be expended in any one town in any one year; but the highway commissioner was instructed to give preference in the allotment of appropriations to the roads "upon which the State had been expending money since 1895."

In 1909, it was provided that any town which had theretofore constructed without State-aid any gravel or macadam road which formed a part of the trunk-line system, as shown on the map of the State accompanying the report of the highway commissioner for the years 1907 and 1908, might offer it to the commissioner to be maintained by the State as a part of the trunk-line system, provided it were first placed in such condition that it would comply with the specifications of the highway commissioner.

In 1911, it was enacted that the entire cost of repairs to the trunk-line roads should be paid by the State; but the trunk-line system appears not to have been established by law until 1913 when, by statute, "a system of trunk-line highways as shown on the accompanying map marked 'Connecticut' showing a system of 14 trunk lines and connecting auxiliaries, Charles J. Bennett, June 2, 1913, State highway commissioner," was established. In the general statutes of Connecticut, revised in 1918, the trunk-line system is again defined as follows:

Sec. 1489. The trunk-line system shall be and remain as established as shown on a map on file in the office of the highway commissioner.

The trunk-line system so established has not remained inviolate, however, for each succeeding general assembly has added to it or changed it.

In 1923, by an amendment of the law the highway commissioner was directed to maintain and keep in repair all State-aid roads, the cost of such repair or reconstruction to be paid in the same manner and from the same funds as if such roads were part of the trunk-line system. By this law all of the State highways, whether trunk-line highways or State-aid roads, are to be dealt with alike, so far as maintenance and reconstruction work are concerned.

Drawbridge Over the Connecticut River in East Haddam

Bridges.—The general assembly in 1915 placed all bridges on the trunk lines having spans 25 feet or greater under the control of the highway commissioner, except bridges built or maintained under a special act of the general assembly, those over railroad and street railway lines, and those in towns of more than 10,000 inhabitants. Where a bridge was wholly within the limits of a town, the cost was to be borne one-half each by the State and the town; when between two towns, or counties, the State was to pay one-half and the towns or counties one-fourth each. If there was a street railway across such a bridge, the towns or counties were to pay one-third, the State one-third, and the street railway company one-third.

By the provisions of section 1512 of the revised statutes of 1918, the highway commissioner is required to maintain all bridges on such highways at the expense of the State, except that when an electric street railway company shall occupy such bridge with its tracks the State is to be reimbursed annually for one-third of the maintenance cost.

The general assembly of 1923 changed the law so as to provide that:

Each bridge on any trunk-line highway shall be built and maintained by the State and that on State-aid roads the cost of both construction and maintenance of any bridge shall be divided between the State and the town in which the bridge is located in the same proportion as the cost of the construction and maintenance of the road; provided the roadway of any bridge built or reconstructed upon any such road shall be at least 23 feet in width and, if crossed by the track of an electric street railway company, the roadway shall be at least 33 feet in width unless there is a double line of tracks in which case the roadway shall be at least 45 feet in width.

Since 1925, by further amendments, all State highway bridges constructed or reconstructed are required to be at least 28 feet in width. All trunk-line bridges carrying a single-track electric street railway must be at least 33 feet wide; and those designed to carry a double-track railway must be at least 45 feet wide. The widths specified, in each instance, are exclusive of sidewalks. Further changes were also made in the distribution of the cost of constructing, reconstructing, and maintaining the State highway bridges.

All tolls and fees for passage over trunk-line bridges were abolished in 1923.

THE REGULATION AND TAXATION OF MOTOR VEHICLES

THE development of State control of trunk-line highways and State-aid roads traced in the foregoing pages has been motivated by the increasing use of motor vehicles and their widening range of operation; and, as in other States, this development has been accompanied by the enactment of regulations and taxing laws designed to protect the roads and road users and to exact from the users a financial contribution to pay in part for the improvement of the roads.

The first law relating to motor vehicles was passed in 1901. It related chiefly to the speed at which such vehicles should be operated and contained no registration or licensing features. In 1903 and 1905 this act was amended; the Secretary of State was made the registering officer, and a fee of $1 for the registration certificate was required. The law was further amended from time to time, and since July 1, 1917, the jurisdiction over motor vehicles has been under the motor vehicle commissioner appointed by the governor.

The motor vehicle commissioner has charge not only of the registration of the vehicles and the licensing of the operators, but also of the enforcement of the provisions of the statutes concerning motor vehicles and their operators. However, the highway commissioner in the case of the State roads and the local authorities on town roads may establish maximum weights permissible on bridges and may issue, in their discretion, permits in writing for extraordinary loads.

The present law provides that no vehicle or vehicle and trailer, or other object exceeding 25,000 pounds in weight including its load, shall be operated upon any highway or bridge without the permission of the State highway commissioner or the local authority as the case may be; that no vehicle or other object, *except a motor vehicle*, the weight of which resting on the surface of such highway or bridge shall exceed 800 pounds per inch of width of metal tire, roller, wheel, or other supporting device, shall be operated without the permit referred to; and that no vehicle equipped with rubber tires, *except a motor vehicle*, shall carry more than the number of pounds per wheel as follows:

Width of tire (inches)	Load per wheel (pounds)	Width of tire (inches)	Load per wheel (pounds)	Width of tire (inches)	Load per wheel (pounds)
3	500	5	1, 700	8	4, 500
3½	750	5½	2, 000	9	5, 500
4	1, 000	6	2, 200	10	6, 500
4½	1, 350	7	3, 500		

Motor vehicles, to which exception is made as above, must be equipped with tires of rubber

or other elastic substance; no metal part of a tire shall be in contact with the surface of the road; on commercial vehicles no axle shall carry less than 20 per cent of the gross weight of the vehicle and its load; commercial motor vehicles equipped with rubber tires shall not exceed 800 pounds weight of load per inch width of rubber when measured at the steel channel of the rubber tire; and the minimum height or thickness of rubber above the outside edge of the steel channel is fixed for tires of varying widths.

The highway commissioner may restrict the use of commercial motor vehicles of over 4 tons capacity on any trunk line or State-aid highway or portion thereof, which in his opinion would be seriously injured by such use; and all damage to highways or bridges caused by loads in excess of the legal limits is chargeable to the owner.

Registration fees.—The original registration fee of $1 per vehicle required by the act of 1905 was changed in 1907 when the flat rate was abandoned and the horsepower of the vehicle was adopted as the basis of the fee. The fees, under this act, ranged from $3 for a vehicle of less than 20 horsepower to $10 for a vehicle of 30 horsepower or more.

Distinction between trucks and passenger cars for purposes of taxation was first made by the act of 1909, which established a fixed fee of $5 for all motor trucks and commercial vehicles regardless of their horsepower; and for passenger cars fixed the fees at 60 cents per horsepower for vehicles of 25 horsepower or more and 50 cents per horsepower for those of less than 25 horsepower. This basis, however, was again changed in 1911, when for the first time the fees for motor trucks were placed upon a capacity basis. By this act the fee for motor trucks of 1,000 pounds capacity or less was placed at $7, and $3 was added for each additional thousand pounds or fractional part thereof over 400 pounds. The same act established the passenger car fees on the single basis of 50 cents per horsepower.

Although the basis of the fees thus established by the act of 1911 remained unchanged until 1921, and the passenger car fees remained unaltered in amount, the motor truck fees were steadily increased by every session of the general assembly between 1911 and 1917, when the schedule shown in Table 1 was adopted; and these rates remained in force until 1921.

In 1920 the highway commissioner had recommended a substantial increase in the fees for both passenger cars and trucks so that the charges would be more commensurate with the highway service rendered; and the increase recommended was provided for by the general assembly of 1921. The new law did away with the old British treasury method of computing the horsepower of the passenger-car motor, substituted a new formula based upon the piston displacement and fixed the fees at 8 cents per cubic inch of displacement with a minimum of $15 per car. It also greatly increased the motor-truck fees, as shown in Table 1, and raised the operator's fee from $2 to $3.

Table 1.—Annual fees for the registration of commercial motor vehicles in 1917 and in 1921

Carrying capacity	Annual fees	
	1917	1921
With pneumatic tires on all wheels:		
1 ton and under	--------	$22. 50
1½ tons	--------	30. 00
2 tons	--------	37. 50
All other commercial motor vehicles:		
Up to 1,000 pounds	$11. 00	-------
1 ton	15. 00	[1] 30. 00
1½ tons	20. 00	40. 00
2 tons	25. 00	50. 00
2½ tons	30. 00	60. 00
3 tons	35. 00	70. 00
3½ tons	45. 00	90. 00
4 tons	55. 00	137. 50
4½ tons	65. 00	162. 50
5 tons	75. 00	187. 50
5½ tons	87. 50	218. 75
6 tons	100. 00	250. 00
6½ tons	112. 50	350. 00
7 tons	125. 00	350. 00
7½ tons	150. 00	-------
8 tons	200. 00	-------

[1] 1 ton or less.

The immediate effect of these changes is reflected in the receipts for the year 1922, shown in Table 2. The percentage of increase in annual revenue changed from a normal of about 20 per cent, which had characterized the period from 1918 to 1921, to 67.5 per cent between

Table 2.—Motor vehicle registration, license fees, etc., in Connecticut, 1918 to 1923

Year	Population [1]	Motor vehicle registration			License fees, etc.[2]		
		Number of vehicles registered	Increase	Persons per vehicle	Amount	Increase	Amount per vehicle
			Per cent			Per cent	
1918	1, 339, 552	86, 067		15. 6	$1, 285, 164		$14. 93
1919	1, 366, 938	102, 410	19. 0	13. 3	1, 516, 137	18. 0	14. 80
1920	1, 394, 324	119, 134	16. 3	11. 7	1, 852, 591	22. 2	15. 55
1921	1, 421, 710	134, 141	12. 6	10. 6	2, 129, 861	15. 0	15. 87
1922	1, 449, 097	152, 977	14. 0	9. 5	3, 567, 745	67. 5	23. 32
1923	1, 476, 483	181, 748	18. 8	8. 1	4, 329, 432	21. 3	23. 82

[1] Estimates of population of the United States, U. S. Dept. Com., 1923.
[2] Gasoline tax receipts are not included.

1921 and 1922, although the 1921–22 increase in registration was only 14 per cent. The revenue per vehicle registered increased from $15.87 in 1921 to $23.32 in 1922.

All fees, fines, etc., collected have been paid into a fund in the State treasury which is used wholly by the highway commissioner for road purposes without specific appropriation by the general assembly.

Gasoline tax.—In 1921 also the State adopted a gasoline tax to augment the funds for the construction, maintenance, or reconstruction of the State highways. This act, as amended in 1923 and 1925, now provides that all distributers of fuels, including gasoline, benzol, and other products, to be used by the purchaser thereof in the propelling of motor vehicles using "combustible type engines" over the highways of Connecticut, are required to procure a license from the commissioner of motor vehicles. The term "distributer" includes any person, association of persons, firm, or corporation, wherever residing or located, who shall cause such fuels to be imported for sale into the State, and also any person, association of persons, or corportation who shall produce, refine, manufacture, or compound such fuels within the State.

All distributers are required to keep records of their sales of such fuels and the records are subject to the inspection of the motor-vehicle commissioner or his inspector. Monthly reports of sales are required to be made to the motor-vehicle commissioner and the tax is paid over to the State treasury by the distributer monthly. Provision is made in the law for the sale of such fuels for use commercially or for manufacturing purposes without payment of the tax.

The tax rate until 1925 was 1 cent per gallon; in that year it was increased to 2 cents; and all money received since 1923 has been available for expenditure by the State highway commissioner for the construction, maintenance, or reconstruction of State highways without specific appropriation by the general assembly for such purpose.

These receipts since the passage of the act in 1921 have been as follows:

Year	Amount
1921	[2] $222, 784
1922	734, 048
1923	880, 722
1924	1, 071, 503

Property tax on motor vehicles.—The grand list made as of October 1, 1923, included for purposes of taxation 162,071 motor vehicles [3] which were valued at $68,618,541, or 3.2 per cent of the total grand list of the State. The tax paid for these vehicles at the rate of 2.194 per cent amounted to $1,505,524, or an average of $9.29 per vehicle.

SALIENT FEATURES OF LEGISLATION

The outstanding features of the present State highway and motor-vehicle laws, reviewed above, are as follows:

1. The absence of any participation by the counties in State highway affairs.

2. The administration of the State highways by a single-headed commission. There have been but three

[2] Four months only.
[3] At that date there were registered 169,041 vehicles.

appointees in the 28 years since the reorganization of 1897.

3. The relatively small portion of the cost of the highways paid by the towns particularly benefited.

4. The financing of the construction and reconstruction work by current funds. No bonds were ever issued specifically for State highway purposes in Connecticut.

5. The large portion of the cost of the State highway work paid in recent years by the user through the registration fees, licenses, and gasoline tax.

6. The road fund in the State treasury upon which the highway commissioner may draw without specific appropriation by the general assembly.

7. The maintenance of all State-aid roads and trunk lines, placed directly under the charge of the highway commissioner.

A Section of the Norwalk-Danbury Road Looking South at Kellogg's Corner

STATE HIGHWAY ORGANIZATION

THE Connecticut State highway department, as previously indicated, has been in operation for 30 years.

James H. MacDonald, a member of the original three-member board of 1895, became in 1897 the highway commissioner, upon the reorganization of the department, by appointment by the governor, and from then until 1913, a period of 16 years, he was at the head of the State highway work.

Upon his retirement, Charles J. Bennett was appointed, February 26, 1913, to take his place. Mr. Bennett remained as highway commissioner until July 1, 1923, on which date he resigned and the present commissioner, John A. MacDonald, succeeded him.

During the period to which this study chiefly relates there were two distinct stages in the State highway work in Connecticut, and the first, under Commissioner James H. MacDonald, may be called the pioneer or preliminary stage.

From 1895 to 1912, the preliminary period, horse-drawn traffic prevailed almost exclusively, particularly before 1910. The roads which were built were planned and constructed to suit the needs of that sort of traffic. Refinements of grade, line, and surface were not so much needed then as now under the enormously increased use of the roads by the motorized traffic.

A large organization was not felt to be necessary, and it was several years after the begin-

ning of road work before inspectors were placed on the construction work. It was not until 1904, nine years after the beginning of State highway work, that an appropriation was made by the general assembly for the employment of engineers to work directly under the supervision of the commissioner. Before that time the selectmen of the town were required to furnish the road plans.

The inspectors in the early days of the work were appointed by the highway commissioner, and usually one of the selectmen of the town in which the road work was in progress received the appointment. The highway commissioner spent much of his time in traveling about the State making personal inspections of the work.

The early appropriations for engineering work were small, averaging only about $43,500 per annum for the period 1904–1913; but it is probable that the inspectors before 1904 were compensated directly from the road allotments, and until 1908 no appropriation was made by the general assembly for repairs or maintenance of the roads, the burden of such work being upon the towns.

By 1913, however, conditions had changed so that Commissioner Bennett felt it necessary to create subdepartments, and in 1915 he described his organization in the following words:[4]

The State highway department of Connecticut is organized under the highway commissioner as follows:

The work itself is separated in three parts, namely, construction of highways, repairs of highways, accounting and records. The men at the head of these subdivisions are actually in charge of the work to which they are assigned, but conferences on all important matters are held with the commissioner, so that in effect each decision of policy receives not only the consideration of the commissioner but of these subordinates, who are actually in touch with the work. These three officials in charge are known as the deputy highway commissioner, in charge of construction; superintendent of repairs, in charge of repairs; and chief clerk, in charge of accounting and records. These men are practically equal in authority except that the deputy commissioner acts for the commissioner in his absence or disability.

Operation.—The department itself is operated by the executives mentioned above, in the following way:

Construction.—The construction department, under the deputy commissioner, has control of the construction of new highways alone, and the work done in this section is in charge of division engineers, as provided by law. The State is at present divided in seven parts,[5] each under a division engineer, who has complete charge of the construction of highways in his particular district. These division engineers report directly to the deputy commissioner and through him to the commissioner. The deputy commissioner makes frequent trips to each division and to each piece of construction work in that division. The division engineers are required to make surveys and preliminary estimates for new highway construction, to stake out the work ready for construction and to supervise and inspect during construction, making monthly estimates of amounts due the contractor, which estimates are sent to the office, checked over, and paid. Each division engineer keeps a sufficient number of assistants and inspectors to properly stake out and supervise construction work. An inspector is kept on every contract job and in some cases, where the work requires it, more than one inspector is employed.

All surveys and plans for the construction of roads are made by the division engineers, as indicated above. These plans, with detailed information as to the character of the soil in the locality through which the road is to pass, a complete statement of the drainage conditions, recommendations as to changes in line and the grade of the road to be established, are sent to the deputy commissioner and by him referred to the office engineering department, which is located in Hartford. Specifications and proposals for bidding are prepared from the information transmitted by the division engineer and the work is advertised for bids through the main office. Before the type of road or grade and line is established, the plans receive careful scrutiny by the deputy commissioner and the commissioner. * * *

Repairs or maintenance.—While this division is placed second, it is unquestionably the most important feature of the highway department's work and on account of its importance has been separated from the construction in order that the men in charge of repairs may put their entire time upon the repairs of highways. It is also assumed that efficient work can only be gained by sufficient supervision. * * *

Under the superintendent of repairs, the State is divided into nine districts,[6] each of which is in charge of a supervisor of repairs. These districts are more numerous and do not coincide with the engineering divisions, because construction work is generally being carried on where roads are not already built. It may be thought that there are too many repair districts, but the department is even now considering increasing the number of repair supervisors in order to get more frequent examination of existing roads.

The supervisors of repairs employ foremen and laborers and carry on the repair of roads (including the surface oiling), by force account. Each supervisor transmits time books showing the amount of time and material used on any particular piece of work. These

[4] Biennial report of the highway commissioner for the two years ended Sept. 30, 1914.

[5] In 1925 there were but five division engineers.

[6] In 1925 there were 11 supervisors of repairs.

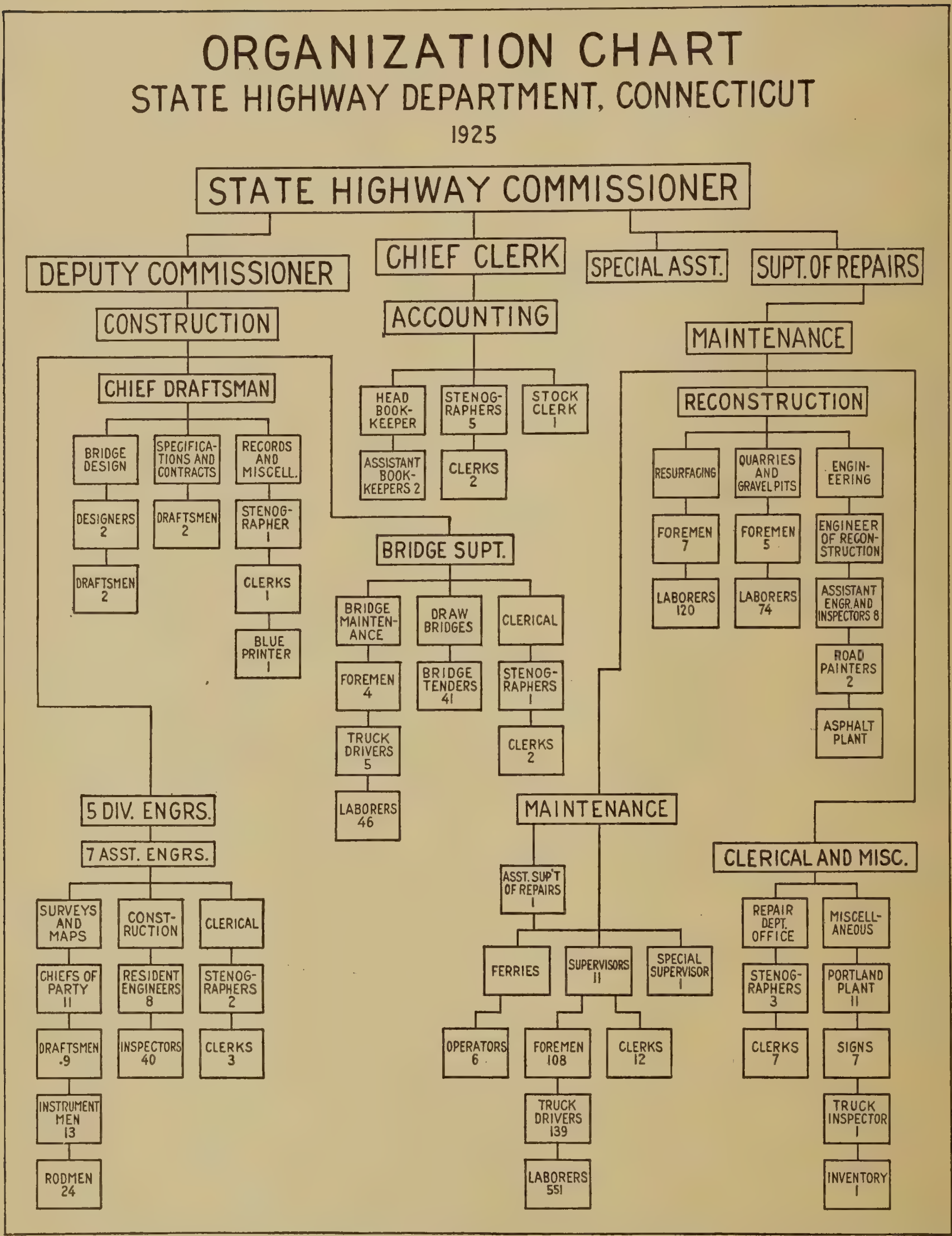


FIG. 1.—CHART OF THE ORGANIZATION OF THE STATE HIGHWAY DEPARTMENT OF CONNECTICUT

time books are submitted every two weeks and payments made direct to the supervisor, who in turn draws checks to the different laborers and team owners employed. The material accounts are paid directly from the office. The information from the time books gives the cost of any particular piece of repair work and the general cost of repairs on any given type of road. * * *

Considerable criticism has arisen in certain instances where experienced labor has been employed rather than the local men who have no knowledge of the work to be done.

The present organization is much the same as that of 1914. Commissioner MacDonald in 1923 made no changes in the general organization or in its personnel.

The present plan of organization is like that of many of the present-day State highway departments, except that the heads of the three major subdivisions report directly to the commissioner and not through the deputy commissioner who is at the head of the construction division.

Figure 1 is a chart showing the organization as it was in 1925. Of the 1,314 officers and employees of the department, 12 are credited to general administrative work, 5 to the accounting office, 231 to the construction division, and 1,066 to the maintenance division of which 1,015 are laborers on repair and reconstruction activities.

The administrative and engineering work of the department have always been kept at low expense. During the period, 1895–1923, the total cost of these items was approximately 5.6 per cent of the gross expenditure of the department, and during the period, 1913–1923, but 5.4 per cent.

In general this low administrative cost is most commendable, but the department now feels the lack of more complete and accurate surveys the need of which in the early days of its history was not appreciated or foreseen. If more money had then been spent on the surveys and preliminary investigation, it would not now be necessary for the highway commissioner to recommend that he be given authority to proceed with a complete survey and search of title of all highway property within the State, because he finds it impossible to establish the highway limits, doubt existing as to the precise location of the State highway rights of way in many cases.

THE STATE HIGHWAYS

THE State highway system of Connecticut is made up of two classes of road—the trunk lines and the State-aid roads. As the name implies, the trunk lines are the more important routes between the larger centers of population and serve as through routes connecting in many instances with the main traveled highways of the neighboring States of New York, Rhode Island, and Massachusetts. The State-aid routes are now mostly local and "feeder" in character.

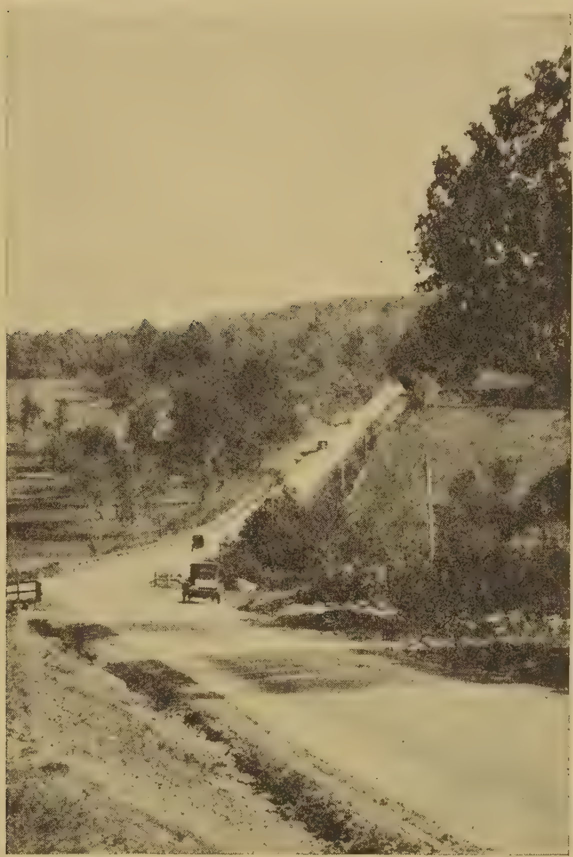
When the State highway work began in 1895 it was wholly on the State-aid basis, a plan by which the State aided the towns in the improvement of the main intertown highways, and it was not until some years later that there was any contemplation of a State system of through or trunk-line highways, and not until 1906 was there any appropriation by the State for trunk-line construction. Roads originally built as State-aid roads in many cases have since been included in the trunk-line system.

In 1923 there had been constructed 666 miles of State-aid road and 1,114 miles of trunk-line highway, a total of 1,780 miles in the State highway system. The State highways then represented 11.4 per cent of the total road and street mileage of the State.

The early highways were mostly of the gravel or macadam type of surface, some as narrow as 12 feet but generally 14 feet wide, with high crowns. These roads were planned and built for horsedrawn traffic and they were well adapted to that use. After 1908, to lessen the disintegration in the roadway surfaces, coatings of tar or asphalt were applied, but there was little change in the general character of the construction until after the change in administration in 1913.

The new commissioner reported that on February 26, 1913, there was a net mileage of State highways of 924 miles of which 605 miles were trunk-line highways and 319 miles State-aid roads. There were then 238 miles

of gravel road, 408 miles of macadam, and 272 miles of road merely graded. Of the more modern types of surfacing there were less than 6 miles altogether.



THE OLD ROADS FOLLOWED IN MANY CASES THE LINES OF ANCIENT TURNPIKES; AND NOT ENOUGH ATTENTION HAS BEEN GIVEN TO THE CORRECTION OF ALIGNMENT WHEN THESE ROADS HAVE BEEN RECONSTRUCTED

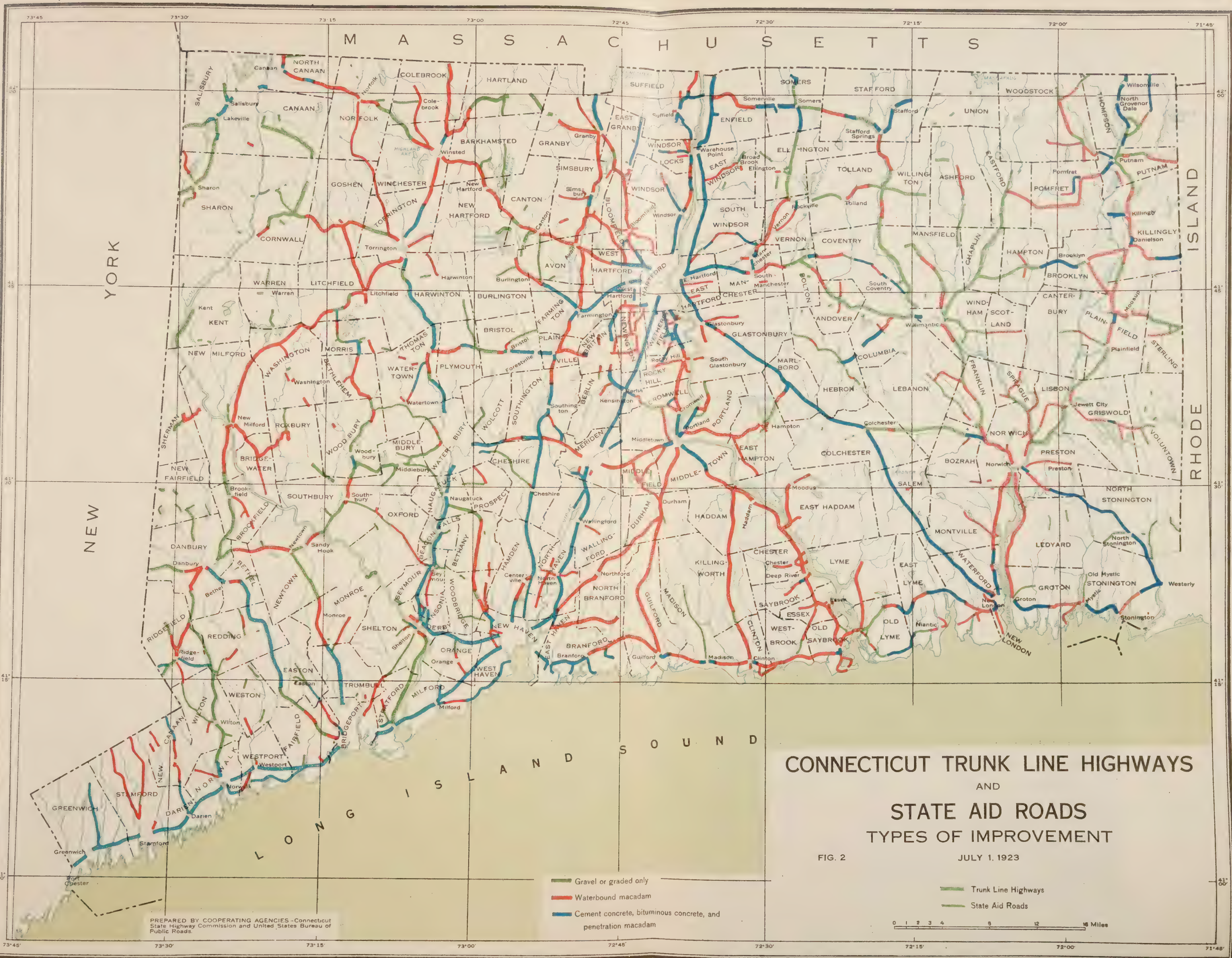
During the period 1913–1923, it became necessary on account of the change in traffic from horse-drawn to motor-driven to change the type of road surface on the important roads. The old roads were widened and strengthened and they, as well as the newer constructions, were bituminized with tar or asphalt. A considerable mileage of cement concrete pavement was also constructed after that type of road surface was developed.

As major repairs became necessary, the roads were thoroughly reconstructed. Few of the main roads are now less than 18 feet wide and the tendency is to make 20 feet the minimum width. On the Boston Post Road between the New York State line and the town of Darien the traffic has made necessary an extraordinarily thick reinforced concrete roadway 36 feet in width.

Under the slow-moving traffic of the earlier days the need of straight roads with curves of long radius was not apparent. The old roads, followed in many cases the rights of way of the ancient turnpikes, and not enough attention was given to the alignment. This resulted in much embarrassment at a later period when it was desired to correct these defects. The land had then increased greatly in value, and in many cases the precise limits of the right of way could not be ascertained from the surveys or records. If the work had not been started until after the horse-drawn traffic period, as was the case in most of the States, the alignment would doubtless have been better suited to the present fast-moving traffic.

The State highways to-day, as a result of the reconstructions made necessary by the extraordinary changes in traffic, are difficult to classify as to type. As nearly as they can be classified, the several types as they existed in 1923 (excluding pavement in the larger cities) are shown on the map, Figure 2. Of whatever type, they are thoroughly and carefully maintained but at great expense. Many of them originally designed to be only gravel roads are now surfaced with bituminous macadam or concrete. The old macadam roads in many instances have been rebuilt or retopped with bituminous or cement concrete. Each type of roadway, however, served well the traffic for which it was planned and by using the old materials in the newer work little or no loss was incurred. In the reconstruction work there are few if any indications that a type of surface too costly for the traffic conditions has been built. In fact an attempt has been made in many instances to make an inferior type of surface serve too long and at too great an expenditure for maintenance. This has been done, not willingly by the department, but because the appropriations at no time since 1913 have been large enough to keep pace with the increasing road use.

Roads suitable for the traffic of 1913 were costing then from $10,000 to $15,000 per mile. Roads now in the same category, because of the greater width and thickness required together with the greatly advanced costs of materials and labor, call for an expenditure of from $30,000 to $75,000 per mile.



ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

State-aid roads.—Table 3 shows the types and lengths of the State-aid roads in 1923, and Appendix I is a table giving the same information by individual towns.

Table 3.—State-aid highways in Connecticut by types, July 1, 1923

Type	Mileage
Graded	80. 28
Gravel	142. 42
Gravel with stone surface	36. 80
Macadam	282. 18
Bituminous macadam	67. 18
Bituminous concrete	8. 94
Cement concrete	47. 95
Brick, wood block, and granite block	. 78
Total	666. 53

Of the total mileage of State-aid roads, 666.53 miles, the roads which were merely graded or surfaced with gravel aggregated 222.7 miles, or 33.4 per cent of the total. The macadam roads, including the gravel roads surfaced with stone, most of which had been surface-treated with asphaltic oil or tar to lessen surface abrasion, totaled 318.98 miles, or 47.9 per cent of the total. Roads of the bituminous type, including bituminous macadam and bituminous concrete, aggregated 76.12 miles, or 11.4 per cent of the whole; and the cement concrete, brick, and other block pavements combined aggregated 48.73 miles, or 7.3 per cent of the total.

In later years, particularly after 1913, the line of demarcation between the State-aid roads and the trunk-line highways became less distinct, and many miles of what were originally State-aid roads were included in the trunk-line system; but the towns continued to pay their proportionate share of the maintenance cost of the State-aid roads until 1923, when the general assembly provided that thereafter the State should bear the whole burden.

Trunk-line highways.—Perhaps the earliest emphatic mention of trunk lines in the highway commissioner's reports is in his report of 1906. He then published a map, reproduced as Figure 3, and described 14 routes through the State which he considered should be designated as trunk-line roads, these routes amounting to about 1,072 miles.

There had been complaint of the detached sections of road built under the State-aid plan, that they did not connect with one another and that a person could not travel far on any of the improved roads without coming to a gap of poor road. In answer to these complaints it was the commissioner's proposal that the subsequent improvements be confined, as nearly as possible, to the system shown in Figure 3, and although there was no official designation of a system by the general assembly until 1913, the commissioner was authorized, in 1906, to expend not more than $25,000 per annum on trunk-line work, but on the State-aid cost principle.

In 1911 the State concluded to bear the whole cost of the maintenance of trunk-line roads; and finally, in 1913, the assembly adopted the trunk-line system as shown on the official map on file in the highway commissioner's office, and this map as it appeared in 1915 is reproduced as Figure 4. The system had then grown from the 1,072 miles proposed in 1906 to 1,340 miles, and it continued to grow in mileage notwithstanding its establishment by statute in 1913, each succeeding general assembly adding to the mileage until 1923, when the system included 1,566 miles, as shown in Figure 5, of which 1,114 miles had been improved. The character of this improved trunk-line mileage in 1923 is shown in Table 4. The details by towns are given in Appendix II.

Table 4.—Improved trunk-line highways in Connecticut by types, July 1, 1923

Type	Mileage
Graded	86. 09
Gravel	214. 75
Gravel with stone surface	45. 74
Macadam	411. 44
Bituminous macadam	94. 14
Bituminous concrete	111. 18
Cement concrete	149. 79
Brick, wood block, and granite block	. 91
Total	1, 114. 04

Of the 1,114 miles improved, 300.84 miles, or 27 per cent, were merely graded or surfaced with gravel. The macadam roads and gravel and stone roads, most of which have been surface-treated, totaled 457.18 miles or 41 per

Fig. 3.—System of Trunk-Line Highways as Proposed in 1906, Including Approximately 1,072 Miles

Fig. 4.—System of Trunk-Line Highways as Proposed in 1915, Including Approximately 1,340 Miles

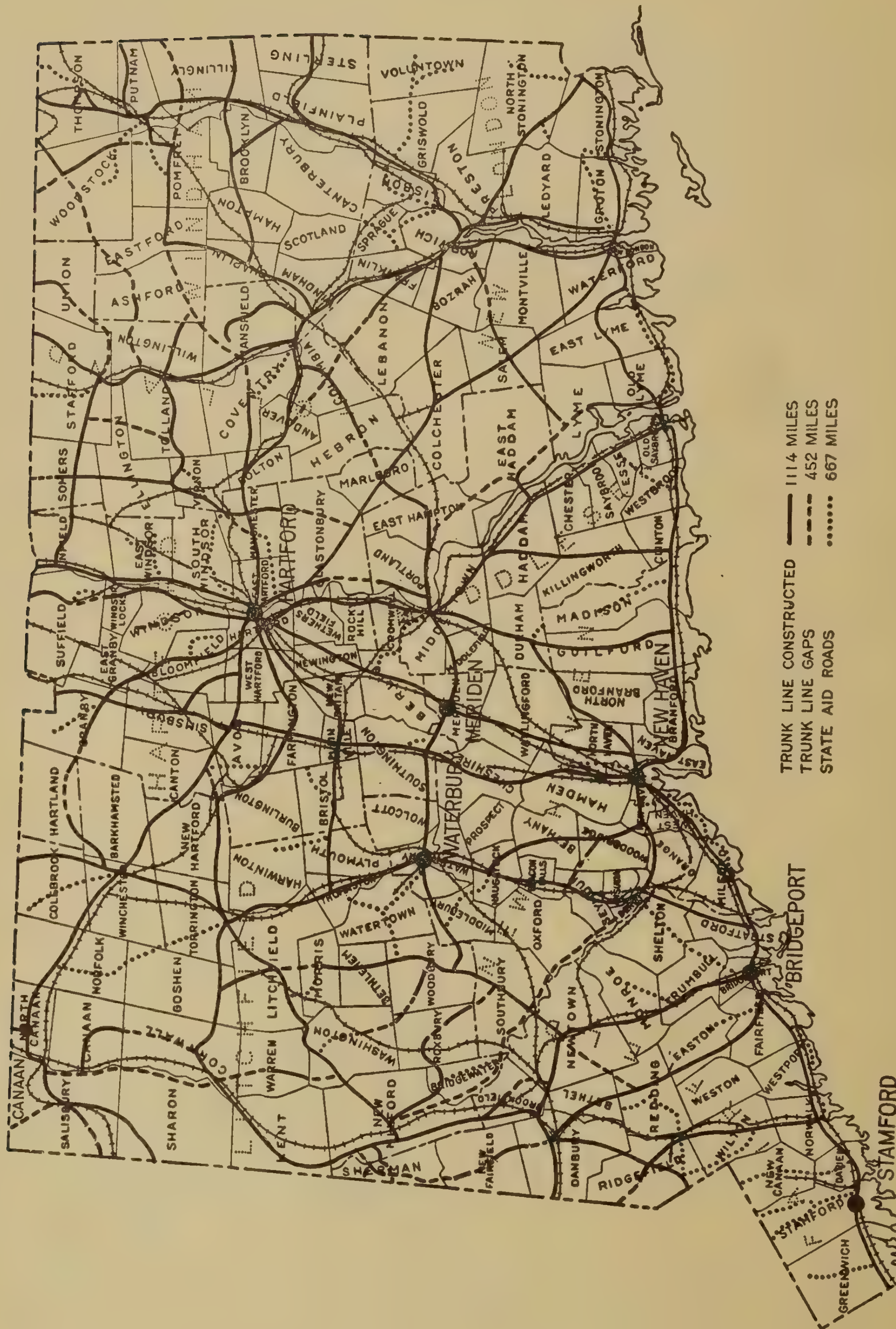


FIG. 5.—SYSTEM OF TRUNK-LINE HIGHWAYS AS PROPOSED IN 1923 AND STATE-AID ROADS IMPROVED UP TO THE SAME YEAR

cent; the bituminous roads aggregated 205.32 miles or 18.5 per cent; and the concrete, brick, and other block pavements, 150.7 miles or 13.5 per cent.

Comparison with other New England trunk-line highways.—For purposes of comparison the types of surfaces on trunk-line highways of the other New England States are shown in relation to the Connecticut improvement in Table 5 and Figure 6. In Vermont all of the State highway work has been done on the State-aid plan, but with the exception of the figures for that State, no State-aid mileage is included in the table.

The data show that of the total mileage of improved road under consideration, 10,235 miles in all New England in 1923, the highest type of roads (Portland cement concrete, bituminous concrete, and penetration macadam) compose but 18.2 per cent of the total; the waterbound-type roads 15.4 per cent, and the gravel or merely graded and drained roads 66.4 per cent.

The best showing is made by Rhode Island, which has but 3.3 per cent of the gravel type, and the poorest by Vermont with only about 2 per cent of its main highways improved with surfacings better than gravel. In Connecticut the types of improvement are very nearly equally divided.

The special significance of this table lies in the relatively small mileage of the higher types of road surface which exists on the main highways of New England, and its indication of a large amount of road improvement remaining to be done to make the State highway systems adequate for the present traffic.

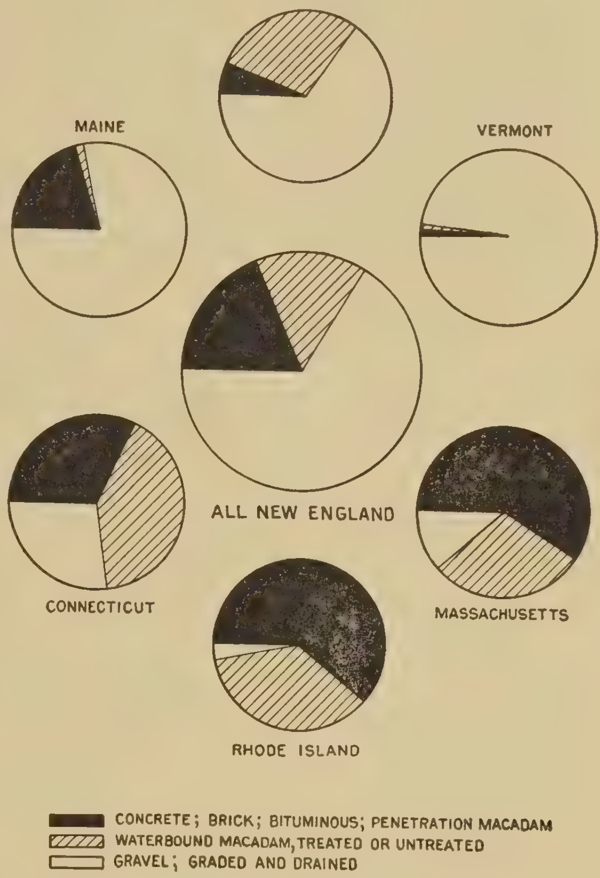


Fig. 6.—State of Improvement of the State Highways of New England (State-Aid Roads not Included Except for Vermont)

Table 5.—State of improvement of State trunk-line highways of New England in 1923 [1]

States	Type of surfacing						
	All types	Gravel or graded only		Waterbound macadam [2]		Cement concrete, bituminous concrete, and penetration macadam	
	Miles	Miles	Per cent	Miles	Per cent	Miles	Per cent
New England	10, 235	6, 799	66. 4	1, 574	15. 4	1, 862	18. 2
Maine	1, 080	847	78. 5	8	0. 7	225	20. 8
New Hampshire	1, 895	1, 247	65. 8	545	28. 7	103	5. 5
Vermont	4, 310	4, 230	98. 2	5	0. 1	75	1. 7
Massachusetts	1, 447	161	11.	421	29.	865	59. 8
Rhode Island	389	13	3. 3	138	35. 5	238	61. 2
Connecticut	1, 114	301	27. 0	457	41. 0	356	32. 0

[1] State-aid highways are not included except in the case of Vermont where all State highways are paid for, in part at least, by the municipalities. The figures for Vermont are for the year 1924.

[2] Includes macadam roads surface-treated with tar or asphalt.

STATE HIGHWAY EXPENDITURES

THE gross expenditures (refunds and other receipts not deducted) of the State highway department from 1895 to July 1, 1923, were $52,552,439, of which the sum of $7,302,842 was disbursed during what may be called the preliminary period 1895–1912, and the balance, $45,249,597, during the modern-traffic period, between 1913 and 1923.

In the annual report of the department for the term ending June 30, 1923, it is stated that since the department was organized in 1895, a total of $46,000,000 has been expended on the State highway system, exclusive of overhead. This means that the refunds by the towns together with the overhead expenditures amounted to approximately $6,500,000 from the beginning of the work in 1895.

Appendix III is an analysis of the data printed in the annual report referred to (item 2, Table B of the report) to show the expenditures for the several divisions of the State highway activities. The analysis shows that 86 per cent of the total expenditure of $52,552,439[7] was made between 1913 and 1923, a period of 11 years, during which time $45,249,597 were disbursed at an average rate of $4,113,600 per annum. From 1895 to 1912, 18 years, the average annual rate of expenditure was $405,713.

Of the total expenditure for the 29 years, 22.9 per cent went for the State-aid work, 63.8 per cent for the trunk-line highways, 7.7 per cent for bridges and 5.6 per cent for administration, engineering, and supervision.

Of the total sum disbursed for the State-aid roads between 1895 and 1912, $4,407,143,[8] 84.9 per cent went for road construction, and 15.1 per cent for repairs.

The total disbursement for the trunk lines, 1895–1912 was $2,380,618,[8] of which 72 per cent went for road construction and 28 per cent for repairs.[9]

There were apparently no expenditures for bridges during this period, but the overhead costs were 7.1 per cent of the total.

During the 11-year period, 1913–1923, of the total disbursement for State-aid roads, 68 per cent went for construction and 32 per cent for repairs. On the trunk-lines 46 per cent during this period went for construction purposes and 54 per cent for repairs, including reconstruction charges. The bridge expenditure was 8.9 per cent of the total, and the overhead costs were 5.4 per cent.

Table 6 is an analysis of the expenditures for maintenance and reconstruction on trunk-line and State-aid highways during the period, 1913–1923. The expenditures are net, the town refunds having been deducted in all cases where it was possible to do so.

LOOKING SOUTH ALONG THE FEDERAL-AID PROJECT NO. 12, A MACADAM ROAD IN THE HOUSATONIC VALLEY

Table 6.—Net maintenance and reconstruction expenditures on Connecticut State highways, 1913 to 1923

Purpose of expenditure	Expenditure	Per cent
MAINTENANCE		
Trunk-line highways	$9, 466, 467	49. 4
State-aid roads	2, 726, 699	14. 2
RECONSTRUCTION		
Trunk-line highways	6, 192, 315	32. 3
State-aid roads	780, 201	4. 1
	19, 165, 682	100. 0

Of the total amount, $19,165,682,[10] expended during this period, $6,972,516 or 36.4 per cent was for reconstruction purposes. The trunk-line maintenance cost was 49.4 per cent of the whole expenditure; trunk-line reconstruction, 32.3 per cent; State-aid maintenance, 14.2

[7] Gross expenditures, town refunds not deducted.

[8] Overhead expenditures not included.

[9] The whole disbursement for trunk-line repairs, $666,841, was charged against the 1912 expenditures.

[10] Overhead expenditures not included.

per cent; and State-aid reconstruction, 4.1 per cent.

It is not practicable to make any detailed analysis of the costs of the construction or maintenance by types of highway or even by routes. The books of account of the department have been kept with great care in so far as concerns the disbursements by appropriations, but little has been done to build up continuous statistical records. The department has never had enough money appropriated to it to establish a statistical department, and it is now practically impossible for the commissioner or any one else to ascertain with any reasonable effort what particular sections of the work have cost either to construct or to maintain. As an example, should one wish to know what the Boston Post Road in New Haven has cost to maintain since it was constructed, he finds that this road is but one of seven routes through New Haven, and that all of the expenses are "pooled" under New Haven repairs. The original time books and vouchers are kept carefully, of course, but the labor involved in making an analysis from such a mass of detail inhibits the task.

STATE AND TOWN RECEIPTS AND EXPENDITURES

HOW the State's expenditures for highways compare with its other expenditures and the sources from which it derives its revenues are shown fully in Appendix IV, for the period 1914 to 1923. This table has been compiled from the comparative financial statements of the State as shown in the State Register and Manual for 1924, and from State highway department records.

During the 10 years period the total receipts by the State were $139,275,542, distributed as follows:

Source of receipts	Amount	Per cent
Railroads and street railways	$15, 432, 437	11. 1
Insurance corporations and companies	11, 567, 758	8. 3
Other corporations	28, 456, 907	20. 4
Inheritance tax	14, 961, 893	10. 7
Town tax	16, 775, 042	12. 1
Highway refunds and receipts	7, 614, 194	5. 5
Motor vehicle and gasoline tax	18, 229, 412	13. 1
Miscellaneous	26, 237, 899	18. 8
	139, 275, 542	100. 0

The total receipts increased from $6,825,809 in 1914 to $22,220,278 in 1923, or more than 225 per cent.

The expenditures for the same period amounted to a total of $137,934,670 distributed as follows:

Item	Amount	Per cent
Legislative and executive	$2, 588, 157	1. 9
Judicial	7, 690, 448	5. 6
Penal and reformatory	6, 874, 039	5. 0
Educational	18, 248, 618	13. 2
Charitable and humane	28, 357, 764	20. 6
Agriculture	4, 714, 634	3. 4
Highways and bridges	41, 766, 021	30. 3
Motor-vehicle department	1, 496, 174	1. 1
Interest on State bonds	4, 949, 590	3. 5
Miscellaneous	21, 249, 225	15. 4
	137, 934, 670	100. 0

As shown by the table in Appendix IV, the total expenditures increased from $9,293,412 in 1914 to $21,203,978 in 1923, or nearly 130 per cent; and the highway expenditures during this period which coincides approximately with the period of modern development, increased from $3,423,218 to $6,912,856 or approximately 100 per cent, the latter bearing a proportion to the total expenditures of the several years of the period varying from a maximum of 36.8 per cent in 1914 to a minimum of 23.4 per cent in 1919.

That this increase in the State's expenditures for all purposes and especially for highways does not represent a material increase in the burden upon the wealth of the State, however, is indicated by the fact that the grand lists of the towns which are supposed to include all taxable property "at a * * *

A Section of the Housatonic River Road North of New Milford Improved with Concrete

fair market value," increased from $997,-500,664 in 1910 to $2,144,303,460 in 1923, or 115 per cent.

But while the ratio of the State's expenditures for highways to its total expenditures has not increased during the period of modern highway development, as shown above, the total expenditures for highways by the State and the cities and towns have increased in slightly greater measure than the total expenditures for all purposes by these units of government; and this despite the fact that the highway expenditures of the State now constitute a much greater part of the total highway expenditure than at the beginning of the modern period.

As shown by Table 7, the combined highway expenditures of the State, cities, and towns in 1912 were 14.3 per cent of the total expenditures for all purposes, whereas the corresponding ratio in 1920 was 19.4 per cent, and in 1924 was 16.2 per cent. In the same period the ratio of the State's expenditures for highways to the total expenditures for that purpose rose from 29.7 per cent in 1912 to 46.3 per cent in 1924.

Table 7.—General expenditures by the State and by cities and towns of Connecticut at several periods compared with the expenditures for roads and bridges

Expenditures	1912	1916	1920	1924
EXPENDITURES FOR ALL PURPOSES				
Grand total[1]	$34, 219, 143	$48, 634, 850	$80, 411, 767	$115, 896, 295
State[1]	8, 105, 750	7, 875, 945	[3] 17, 096, 041	24, 127, 500
Towns[2]	26, 113, 393	40, 758, 905	63, 315, 726	91, 768, 795
Per cent				
State	23. 7	16. 2	21. 3	20. 8
Towns	76. 3	83. 8	78. 7	79. 2
EXPENDITURES FOR ROADS AND BRIDGES				
Total	$4, 894, 066	$7, 176, 357	$15, 583, 419	$18, 788, 243
Percentage of grand total	14. 3	14. 8	19. 4	16. 2
State	1, 453, 512	1, 950, 948	5, 634, 366	8, 689, 959
Towns[2]	3, 440, 554	5, 225, 409	9, 949, 053	10, 098, 284
Per cent				
State	29. 7	27. 2	36. 2	46. 3
Towns	70. 3	72. 8	63. 8	53. 7

[1] County expenditures omitted.
[2] Includes city, borough, and fire district expenditures.
[3] Exclusive of $2,278,815 invested in United States bonds.

RÉSUMÉ OF STATE HIGHWAY ACTIVITY TO DATE

IN THE foregoing pages we have traced the development of State highway legislation, the growth of the State highway organization, the increase in the State highway expenditures, and the progressive improvement of the State highways in response to the growing demand of a rapidly increasing class of regular highway users.

It has been shown that, beginning in 1895, when the State first undertook to participate in highway improvement, that participation has grown from a monetary contribution and an advisory relation to the construction of roads selected, surveyed, and planned by local authorities, to a positive control over the construction and maintenance of the roads of a defined system, including entire responsibility for the design, construction, and upkeep.

From a contribution of one-third of the cost of constructing roads which thereafter were maintained at the expense of the towns, and an annual expenditure limited to $75,000 a year, the State has gradually assumed a larger and larger responsibility until it is now paying the entire cost of the trunk-line construction, which constitutes the great bulk of the work done, and the entire cost of maintaining both the trunk-line and State-aid roads, the expenditure in 1924 amounting to nearly $8,700,000.

In the beginning the State highway department consisted of the commission and its clerical assistants. There were no engineering subordinates. To-day its duties require an elaborate engineering organization employing over 1,300 persons, most of them needed because of the transfer of control over the maintenance of the main roads of the State from the towns to the State department.

From a method of financing the State's highway operations, which depended in the beginning entirely upon the taxation of property, there has developed a system under which the taxation of the increasing numbers of motor vehicles and the fuel used by these vehicles supplies a fund which is upwards of 70 per cent of the gross highway expenditure of the State and over 90 per cent of the net expenditure after deduction of the refunds paid by the towns.

As for the improvement of the highways it has been shown that the interval since the creation of the State agency in 1895 has been divided into two periods; the first, or pioneer period, extending to 1913, and the period of modern development, which, beginning at that time, extends to the present day. During the earlier years of the pioneer period the roads

A Section of the Kent-Macedonia Road, Trunk Line No. 127, Surfaced with Waterbound Macadam. (The Old Location is Shown at the Right)

to be improved were chosen by the selectmen of the towns and were surveyed, planned, constructed, and maintained by the local officials. Under this system no continuity of improvement was possible. The roads built were surfaced mostly with gravel or macadam. Planned for horse-drawn traffic and well adapted to that use they were totally inadequate for the heavy motor vehicle traffic which has developed during the last decade. By the close of the earlier period there were over 900 miles which had been graded and for the most part surfaced with gravel or macadam. Less than 6 miles were more durably surfaced. The majority of these old surfaces have been rebuilt or incorporated in the wider and more adequate improvements which have been made during the period of modern development.

In this latter period there has been considerable progress toward the consistent improvement of a connected system of main roads. From its beginning there has been a more or

less definite plan of trunk-line highway development which has been amended and added to repeatedly, so that in 1923 it included approximately 1,566 miles of which 1,114 miles had been variously improved. The improvement that has been made and the maintenance of the improvements under a rapidly growing motor-vehicle usage are highly commendable. Yet the fact that only 32 per cent of the improved State roads in 1923 was surfaced with concrete, bituminous, or other types of modern pavements is sufficient to indicate that a great deal of work remains to be done to make the State highway system truly adequate for the traffic of the present and the immediate future.

The State highway commissioners for several years have called attention emphatically to the rapidly increasing traffic on the State highways; to their inability to construct new roads or to reconstruct the existing State highways as fast as the public demands and the needs develop; and to the fact that the roads already built are deteriorating faster than the maintenance forces can keep them in repair.

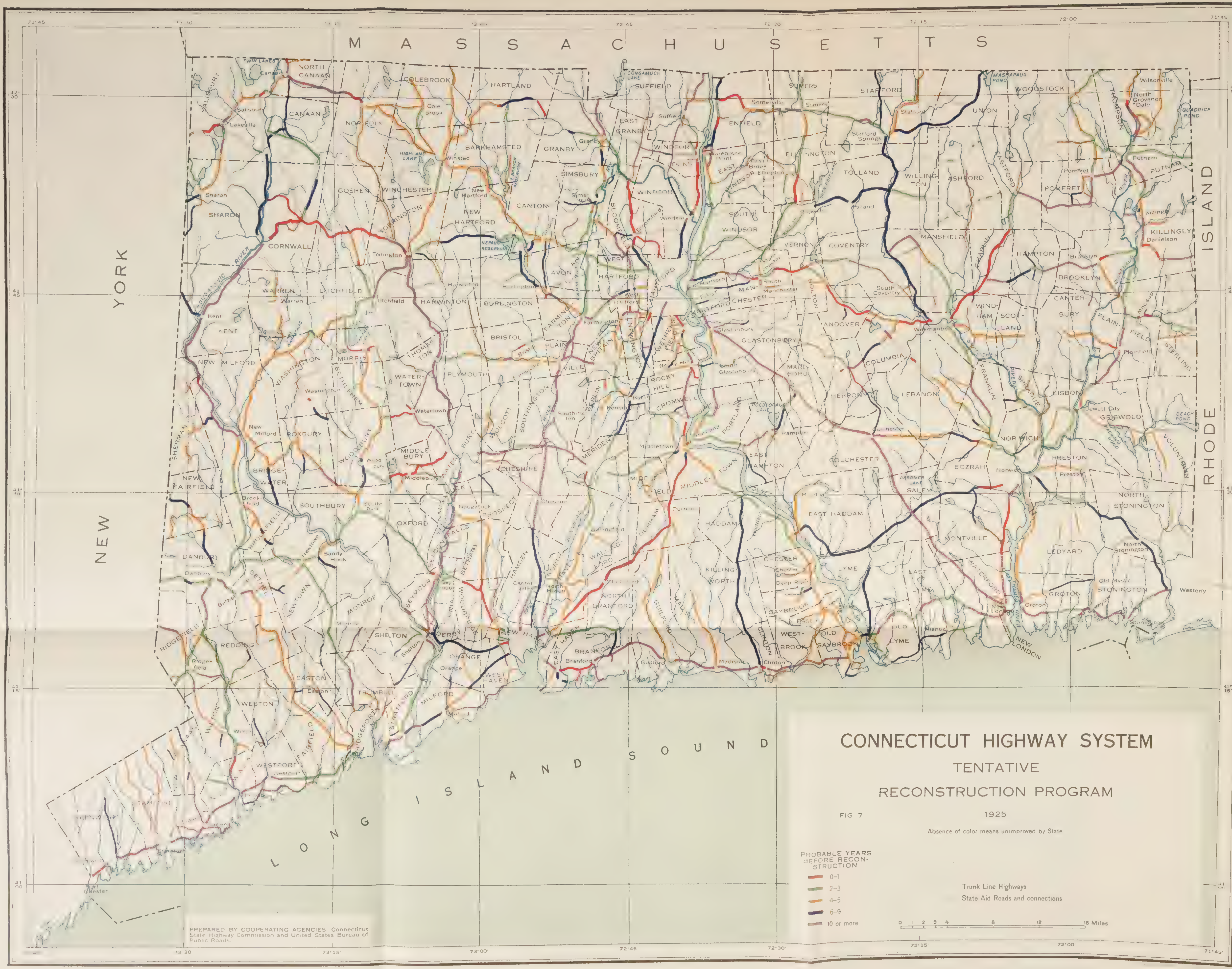
The present commissioner has recommended a program for State-aid roads through a 10-year period, so as to build up a comprehensive and well-devised secondary system to supplement the trunk-line highways; providing also that future additions to the trunk-line highways be made contingent on the towns furnishing to the State rights of way 100 feet wide, so as to keep pace with the growth of motor-truck and passenger transportation.

THE STATE HIGHWAY COMMISSIONERS FOR SEVERAL YEARS HAVE CALLED ATTENTION TO THE RAPIDLY INCREASING TRAFFIC ON THE STATE HIGHWAYS

This plan would, he said, "permit the establishment of a hard-surfaced road in the center; would provide space for beautification, such as the planting of shade trees, the systematic erection of telegraph, telephone and power lines, and ample provision for sidewalks, trolley lines, sewers, and waterways."

He also recommended a new classification of the State highways based on traffic volume and intensity of traffic as follows:

> Terminal highways, meaning highways in industrial areas or which connect centers of population not widely separated where there is need for the trucking of loads in large-capacity trucks.


CONNECTICUT HIGHWAY SYSTEM
TENTATIVE
RECONSTRUCTION PROGRAM
FIG 7
1925
Absence of color means unimproved by State
PROBABLE YEARS BEFORE RECON-STRUCTION
0–1
2–3
4–5
6–9
10 or more
Trunk Line Highways
State Aid Roads and connections
0 1 2 3 4 8 12 16 Miles
PREPARED BY COOPERATING AGENCIES Connecticut State Highway Commission and United States Bureau of Public Roads
MASSACHUSETTS
NEW YORK
RHODE ISLAND
LONG ISLAND SOUND

Class A highways where there is a considerable volume of heavy truck hauling, but not so great as on the terminal highways.

Class B highways where there is a comparatively small volume of heavy truck hauling of a type not necessitating the use of extremely heavy units.

Class C highways, those highways not included in terminal highways, Class A and Class B highways, where the traffic consists chiefly of passenger motor vehicles.

His reason for the foregoing classification was that, in his opinion, 90 per cent of the present highway traffic can be served adequately by a medium-priced road and that it is not economical to provide for the carriage of heavy loads on all of the highways.

The department has made a tentative program of work to be done during the 15-year period beginning with the year 1925 which is shown graphically on the map, Figure 7. Within 10 years it is estimated that 1,506 miles of State highway must be rebuilt or resurfaced. The expectancy of "probable years before reconstruction" is as follows:

	Miles
1 year and less	206
2 to 3 years	436
4 to 5 years	642
6 to 9 years	222
10 years and more	339

In other words, 206 miles of the system need immediate reconstruction; 436 miles may last from 2 to 3 years before such radical treatment is required, etc.

The department is not ready to make public the estimates of the annual expenditure which this program will entail, if indeed it is able to make such an estimate with any degree of accuracy, but it is evident that the State highway budget must be increased greatly to do the work as planned.

Since the beginning of the reconstruction work about the year 1913, 461 miles of trunk-line highway and 102 miles of State-aid roads have been reconstructed, a total of 563 miles. The new program calls for the rebuilding of nearly 1,300 miles in about 5 years, and before the year 1930.

ECONOMIC CHANGES AFFECT ROAD PROGRAM

SINCE the creation of the State highway department in 1895 changes have occurred in the economic structure of the State which have had a most important bearing upon the development and use of the highways. Most important of these changes, of course, so far as the highways are concerned, is that which has taken place in the mode of highway transportation as a result of the introduction and development of the motor vehicle; but there have been other changes which also have had and will continue to have an influence on the improvement of the highways.

Among these is the gradual shift in the occupation of the people of the State from agriculture to industry, and the accompanying movement of the population from the rural communities to urban centers. Connecticut has not been an agricultural State, as the term is generally understood, for many years, but the fact that between 1900 and 1920 the improved farm land of the State decreased by 34 per cent indicates that farming as an industry occupied relatively a much more important place when the State highway department was created than at present.

The other side of the picture is indicated by the fact that between 1899 and 1919 the value of the State's manufactured products increased 342 per cent. In view of these industrial changes, it is not surprising that there has been throughout the period of the State's active participation in the work of highway improvement a shift of population from the rural areas to the cities which has resulted in actual decreases in the population of many of the towns, still further reducing their already sparse population; and this tendency continues.

The map, Figure 8, shows in seven groups the relative density of the population of the several towns according to the Federal census of 1920. The map was prepared from data which are given in full in Appendix V and summarized in Table 8. Group A in the latter table is composed of those towns which have a population density of less than 64 persons to the square mile. In other words there are in this group at least 10 acres of land to each inhabitant. Group B comprises the towns which have from 64 to 127 persons per square mile; Group C, from 128 to 319 persons per square mile; and the other groups are

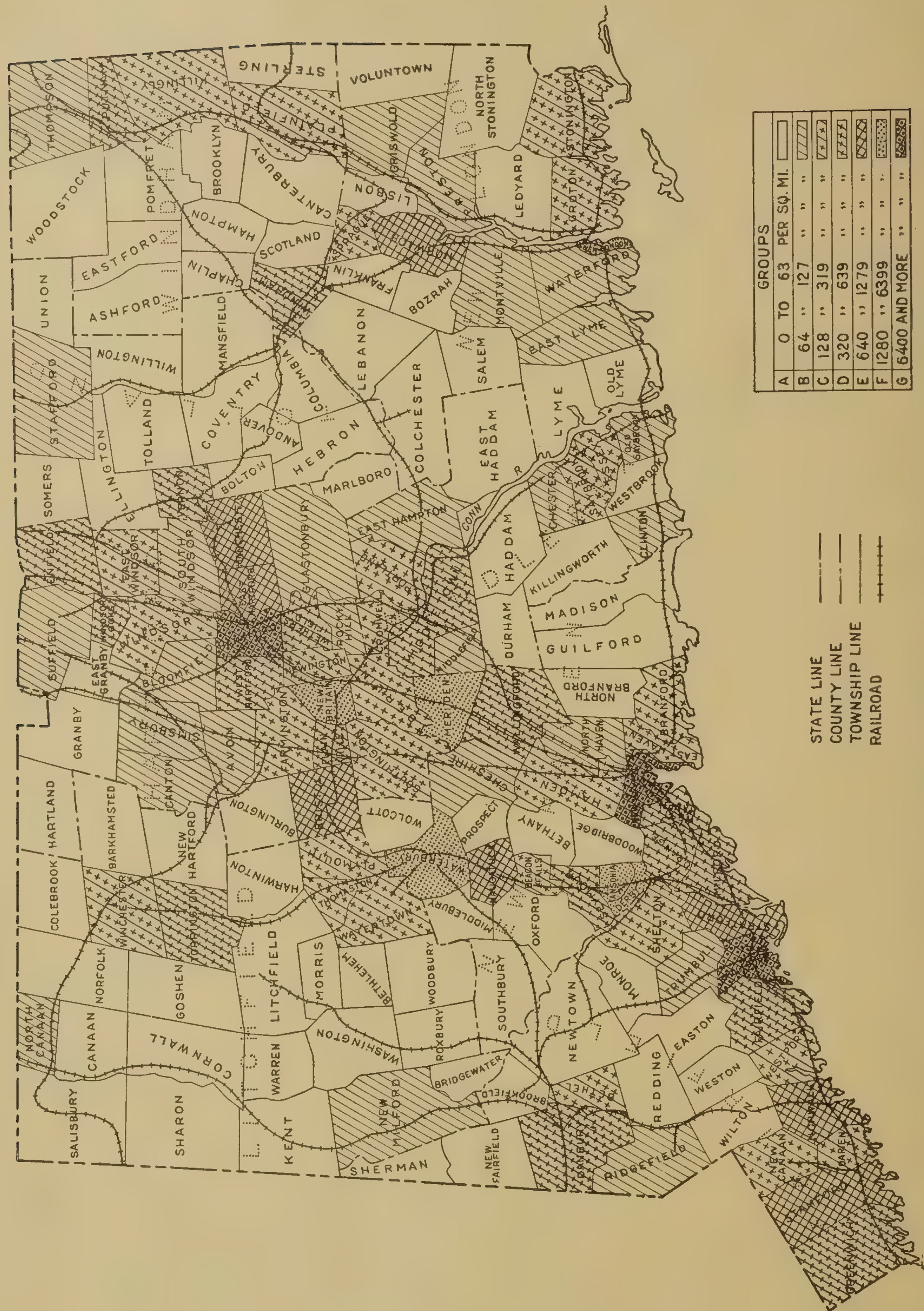


FIG. 8.—RELATIVE POPULATION DENSITY OF CONNECTICUT TOWNS IN 1920

defined in a similar manner as indicated in the table.

Groups A, B, and C are clearly rural since all towns in these groups have sufficient area to provide for every inhabitant at least 2 acres of land. Groups D, E, F, and G, 34 towns in all, may be classed as wholly or partly urban in character, although towns ranging from 2 acres per inhabitant to 2 persons per acre (Groups D and E) are not very densely settled. As will be seen by reference to Table 8 the rural towns include 4,049 square miles, or 84 per cent of the total land area of the State.

Table 8.—Population of Connecticut in 1920 grouped on the basis of the number of persons per square mile of land area

Group and number of persons per square mile	Number of towns[1]	Population	Area in square miles	Average number of persons per square mile
A (0–63)	80	87, 800	2, 574	34
B (64–127)	26	74, 571	809	92
C (128–319)	28	148, 853	666	224
D (320–639)	17	209, 384	446	469
E (640–1,279)	8	175, 531	195	900
F (1,280–6,399)	6	240, 364	73	3, 293
G (6,400 and over)	3	444, 128	57	7, 792
State	168	1, 380, 631	4, 820	287

[1] Cities included.

The tendency of the population of the State to shift from the rural to the urban areas is shown by Table 9. In this table it is shown that the population of the Group A towns, as a class, actually decreased in each of the last two decennial periods, the decrease amounting to 2.5 per cent between 1900 and 1910 and to 5.2 per cent between 1910 and 1920. There were 54 towns of a total of 80 in this group which decreased in population during the 20 years. Group B as a whole shows small gains in both decades, but 6 towns of a total of 26 included in it showed a loss of population between 1900 and 1920, and 9 lost between 1910 and 1920. Group C has 2 towns of a total of 28 which lost population between 1900 and 1920, and 2 which showed a decrease between 1910 and 1920. There were no losses in the other groups, except in the case of 4 towns in Group D, which lost population between 1910 and 1920. The greatest gains during both periods were recorded in the urban towns. The towns in Groups A, B, and C which lost in population in the two decades occupy 2,004 square miles or 41.6 per cent of the total State area. The Group A towns which lost in population occupy 1,819 square miles, or 37.7 per cent of the area of the State.

The significance of these population statistics appears when they are examined in relation to the mileage of highways in the towns of the several groups. This relation to the total mileage of highways and to the trunk-line and State-aid roads, respectively, is shown in Tables 10, 11, and 12. Of particular interest in these tables is the fact that the Group A towns which have a density of population in no case exceeding one person to 10 acres and an average density of one person to 18 acres,

Table 9.—Population changes by groups of Connecticut towns between 1900 and 1910 and between 1910 and 1920

Group[1]	Number of persons per square mile	Population			Increase		Per cent of increase	
		1900	1910	1920	1900–1910	1910–1920	1900–1910	1910–1920
A	0–63	94, 962	92, 599	87, 800	[2] 2, 363	[2] 4, 799	[2] 2. 5	[2] 5. 2
B	64–127	64, 856	68, 324	74, 571	3, 468	6, 247	5. 3	9. 1
C	128–319	106, 143	122, 843	148, 853	16, 700	26, 010	15. 7	21. 2
D	320–639	133, 135	168, 510	209, 384	35, 375	40, 874	26. 6	24. 3
E	640–1,279	104, 256	134, 981	175, 531	30, 725	40, 550	29. 5	30. 0
F	1,280–6,399	146, 195	192, 925	240, 364	46, 730	47, 439	32. 0	24. 6
G	6,400 and more	258, 873	334, 574	444, 128	75, 701	109, 554	29. 2	32. 7
State		908, 420	1, 114, 756	1, 380, 631	206, 336	265, 875	22. 7	23. 9

[1] For explanation of population groups see page 31.

[2] Decrease.

Table 10.—Street and highway mileage in Connecticut in 1925 classified by population groups [1]

Population group	Number of persons per square mile	All highways		State highways				City and town highways	
				Trunk-line highways		State-aid roads			
		Miles	*Per cent*	*Miles*	*Per cent*	*Miles*	*Per cent*	*Miles*	*Per cent*
A	0–63	6, 724	43. 2	488	43. 8	267	40. 0	5, 969	43. 3
B	64–127	2, 319	14. 9	198	17. 7	128	19. 3	1, 993	14. 5
C	128–319	2, 464	15. 9	191	17. 1	123	18. 4	2, 150	15. 6
D	320–639	1, 949	12. 5	149	13. 4	74	11. 1	1, 726	12. 5
E	640–1,279	883	5. 7	53	4. 8	45	6. 7	785	5. 7
F	1,280–6,399	609	3. 9	25	2. 3	22	3. 4	562	4. 1
G	6,400 and more	604	3. 9	10	. 9	8	1. 2	586	4. 3
State		15, 552	100. 0	1, 114	100. 0	667	100. 0	13, 771	100. 0

[1] The mileage of city and town highways is an estimate based in part on U. S. Dept. of Agriculture Bul. No. 388, 1917, revised by correspondence with the city and town officials and revised in part by measurements in the field made by employees of the State highway department.

Table 11.—State-aid highways in Connecticut, July 1, 1923, classified by population groups

Population group	Number of persons per square mile	All types	Graded only	Gravel	Gravel with stone surface	Macadam	Bituminous macadam	Bituminous concrete	Cement concrete	Brick, wood block, and granite block
		Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
A	0–63	267. 22	67. 29	81. 35	11. 52	90. 75	16. 31	------	------	------
B	64–127	127. 92	1. 55	21. 93	12. 42	67. 63	14. 56	0. 34	9. 49	------
C	128–319	122. 89	9. 32	23. 05	7. 24	47. 97	15. 48	2. 26	17. 51	0. 06
D	320–639	73. 93	. 25	10. 62	3. 96	28. 32	16. 34	3. 28	11. 16	------
E	640–1,279	44. 49	. 93	4. 92	1. 66	29. 24	2. 13	. 15	5. 46	------
F	1,280–6,399	22. 33	. 94	. 55	------	12. 46	2. 00	2. 60	3. 06	. 72
G	6,400 and more	7. 75	------	------	------	5. 81	. 36	. 31	1. 27	------
State		666. 53	80. 28	142. 42	36. 80	282. 18	67. 18	8. 94	47. 95	. 78

Table 12.—Trunk-line highways in Connecticut, July 1, 1923, classified by population groups

Population group	Number of persons per square mile	All types	Graded only	Gravel	Gravel with stone surface	Macadam	Bituminous macadam	Bituminous concrete	Cement concrete	Brick, wood block, and granite block
		Miles	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*	*Miles*
A	0–63	487. 96	73. 67	133. 34	27. 31	182. 74	40. 08	0. 24	30. 49	0. 09
B	64–127	198. 34	4. 24	22. 14	11. 23	95. 50	24. 37	16. 05	24. 81	------
C	128–319	190. 73	3. 14	17. 09	4. 57	71. 35	19. 38	31. 01	43. 79	. 40
D	320–639	148. 82	4. 02	28. 78	2. 63	44. 67	9. 36	30. 31	28. 92	. 13
E	640–1,279	53. 22	1. 02	11. 12	------	11. 87	. 35	20. 18	8. 52	. 16
F	1,280–6,399	25. 27	------	2. 28	------	5. 31	------	7. 35	10. 29	. 04
G	6,400 and more	9. 70	------	------	------	------	. 60	6. 04	2. 97	. 09
State		1, 114. 04	86. 09	214. 75	45. 74	411. 44	94. 14	111. 18	149. 79	. 91

have within their borders 6,724 miles or 43.2 per cent of the 15,552 miles of highway in the State, 267 miles or 40 per cent of the improved State-aid roads, and 488 miles or 43.8 per cent of the improved trunk-line highways. It has already been shown that these towns are not only sparsely populated but are actually decreasing in population, yet it will later be shown that the trunk-line highways passing through them carry exceptionally heavy traffic and require the highest type of improvements. Obviously such improvements and their maintenance are possible only when they are financed by the State, which explains the necessity for paying the entire cost of constructing and maintaining the trunk-line highways from State funds.

There are only nine towns in the State in which no trunk-line road had been built by 1923. Six of these towns are in Group A and three in Group B, but only two of the nine have neither a State-aid road nor a trunk-line within their boundaries. The State highway system, therefore, reaches every town in the State save two.

INCREASE IN MOTOR VEHICLES

From the highway standpoint, however, the most important economic change that has occurred is the substitution of motor vehicles for horse-drawn vehicles and the resulting tremendous increase in the number, weight, speed, and range of travel of vehicles using the highways.

Connecticut has had in this respect much the same experience as other States. But, as the State is small and located between the thickly populated States of New York, Massachusetts, and Rhode Island, it has had to provide highway service not only for the increasing numbers of motor cars owned within its own borders, but, on the main roads in particular, for a large traffic from adjacent States as well.

The motor vehicles registered in the State, as reported by the State authorities without deduction of registrations and other corrections commonly made in the statistics prepared by the Bureau of Public Roads, increased from 23,200 in 1913 to 218,489 in 1924, an increase in number of 195,289, or 842 per cent. In 1913 there were 52 persons [11] for each motor vehicle registered. In 1924 there was one motor vehicle for every 6.3 persons,[12] and in this respect, also, the State has followed the general trend throughout the United States. In 1924, when the number of persons per vehicle in Connecticut was 6.3, the average corresponding ratio for the New England States was 1 to 6.5,[12] and for the entire United States, 1 to 6.[12] Figure 9 shows the number of persons per motor

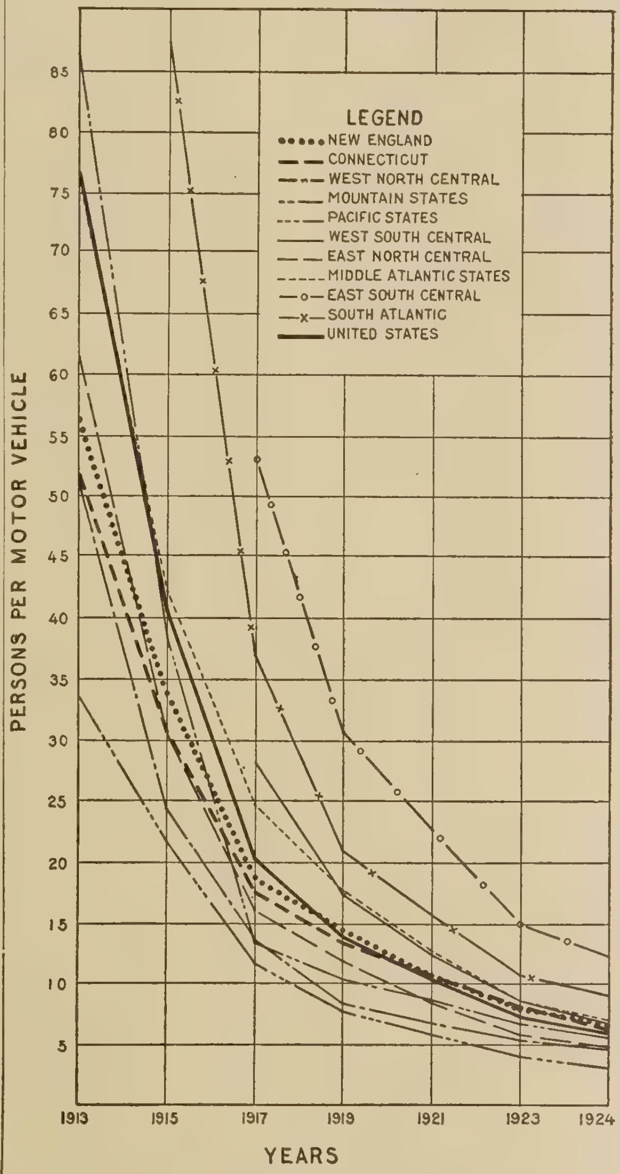


FIG. 9.—PERSONS PER REGISTERED MOTOR VEHICLE IN CONNECTICUT, THE UNITED STATES, AND IN GROUPS OF STATES

[11] Population basis, United States census, 1910.

[12] Population basis, United States census, 1920.

vehicle registered in the United States and in the several groups of States for seven different years between 1913 and 1924.

Statistics of motor vehicle ownership in Connecticut in 1924 are given in Tables 13, 14, and 15. For that year, the latest for which the complete official statistics are available, Table 13 shows the distribution of motor vehicles by population groups and the number of persons per motor vehicle. While, as indicated, there were 6.3 persons to the motor vehicle in the whole State, in Group A, the most sparsely settled area, there were but 4.2 persons to each vehicle. Contrasting Groups A, B, and C, composed of 134 towns of undoubted rural character, and including 79.8 per cent in number of all towns of the State with the urban Groups D, E, F, and G, it will be seen that the rural towns with 28.7 per cent of the motor vehicles have an average of 5 persons to the vehicle, while the city groups have 6.9 persons to the vehicle.

Considering the passenger cars separately, it will be seen that in the whole State there are 7.5 persons per car, that Group A has again the smallest number of persons per car (5.1), and that Groups A, B, and C have an average of 5.9 persons per car as against 8.1 persons per car in Groups D, E, F, and G. But only 28.59 per cent of the passenger cars registered are from the rural town groups.

Of the motor trucks, 29.3 per cent were registered from the rural towns, indicating that the distribution of the trucks is very much the same as in the case of the passenger cars.

Table 14 shows the distribution of motor trucks in Connecticut by rated capacities and by population groups in 1924. As perhaps should be expected, Group G, comprising the three largest cities of the State—New Haven, Bridgeport, and Hartford—has more trucks of all sizes than any other single group. In these three cities were located 30 per cent of all of the trucks.

The trucks of 1 ton capacity and under constituted 70.6 per cent of all of the trucks. If trucks of a capacity greater than 2½ tons be called "heavy" and those of a lesser capacity be called "light", then 90 per cent of all the trucks in Connecticut are "light" trucks. The trucks of a rated capacity in excess of 5 tons are but 383 in number and form but 1.1 per cent of the total. Ninety per cent of them are registered from the city groups.

Table 15 shows a classification of trucks in four of the New England States in 1924—Maine, Massachusetts, Rhode Island, and Connecticut. The trucks of 1 ton capacity and under in all of these States constitute 71.3 per cent of the total truck registration, and in general the Connecticut truck registration by capacity follows closely the averages of the four States. The percentages for Massachusetts and Connecticut are practically identical for most of the capacities.

It is this change in the character and number of the vehicles using the highways of the State

Table 13.—Distribution of Connecticut motor vehicles by population groups in 1924

Population group	Number of persons per square mile	All motor vehicles			Passenger cars				Motor trucks		
		Number	Per cent of total	Persons per vehicle[1]	Number	Per cent of total	Per cent of all motor vehicles in group	Persons per vehicle[1]	Number	Per cent of total	Per cent of all motor vehicles in group
A	0–63	20, 754	9. 5	4. 2	17, 314	9. 4	83. 4	5. 1	3, 440	10. 31	16. 6
B	64–127	15, 130	6. 9	4. 9	12, 694	6. 8	83. 9	5. 9	2, 436	7. 29	16. 1
C	128–319	26, 808	12. 3	5. 6	22, 905	12. 4	85. 5	6. 5	3, 903	11. 69	14. 5
D	320–639	37, 419	17. 1	5. 6	32, 195	17. 4	86. 0	6. 5	5, 224	15. 65	14. 0
E	640–1,279	29, 618	13. 5	5. 9	25, 669	13. 9	86. 7	6. 8	3, 949	11. 82	13. 3
F	1,280–6,399	29, 415	13. 5	8. 2	24, 988	13. 5	84. 9	9. 6	4, 427	13. 26	15. 1
G	6,400 and more	59, 345	27. 2	7. 5	49, 335	26. 6	83. 1	9. 0	10, 010	29. 98	16. 9
State		218, 489	100	6. 3	185, 100	100	84. 7	7. 5	33, 389	100	15. 3

[1] Population basis, United States census, 1920.

Table 14.—Distribution of Connecticut motor trucks by rated capacities and population groups in 1924

Population group	Number of persons per square mile	Motor truck capacities (tons)							
		All sizes		1 and under		1–2		2–2½	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
A	0–63	3, 440	10. 3	2, 767	11. 7	501	8. 8	53	6. 7
B	64–127	2, 436	7. 3	1, 900	8. 1	391	6. 9	41	5. 2
C	128–319	3, 903	11. 7	2, 924	12. 4	600	10. 5	80	10. 0
D	320–639	5, 224	15. 6	3, 799	16. 2	856	15. 0	126	15. 8
E	640–1,279	3, 949	11. 8	2, 721	11. 5	760	13. 3	103	12. 9
F	1,280–6,399	4, 427	13. 3	2, 930	12. 4	801	14. 1	128	16. 0
G	6,400 and more	10, 010	30. 0	6, 537	27. 7	1, 796	31. 4	266	33. 4
State		33, 389	100	23, 578	100	5, 705	100	797	100

Population group	Number of persons per square mile	Motor truck capacities (tons)									
		2½–3		3–4		4–5		5–6		Over 6	
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
A	0–63	47	5. 7	45	4. 2	22	2. 1	3	0. 9	2	6. 1
B	64–127	36	4. 4	39	3. 7	21	2. 0	8	2. 3	------	------
C	128–319	82	10. 0	108	10. 2	84	8. 1	24	6. 9	1	3. 0
D	320–639	105	12. 8	127	11. 9	159	15. 3	44	12. 6	8	24. 2
E	640–1,279	95	11. 6	99	9. 3	103	9. 9	63	18. 0	5	15. 2
F	1,280–6,399	117	14. 2	163	15. 3	195	18. 7	92	26. 3	1	3. 0
G	6,400 and more	340	41. 3	482	45. 4	457	43. 9	116	33. 0	16	48. 5
State		822	100	1, 063	100	1, 041	100	350	100	33	100

Table 15.—Motor trucks registered in 1924 in four New England States classified by capacity

Truck capacity	Registered motor trucks by States									
	Four States		Maine		Massachusetts [1]		Rhode Island		Connecticut	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
All capacities	157, 529	100. 0	17, 676	100. 0	90, 400	100. 0	16, 064	100. 0	33, 389	100. 0
1 ton and under	112, 325	71. 3	14, 360	81. 3	64, 764	71. 6	9, 623	59. 9	23, 578	70. 6
1 to 2 tons	28, 742	18. 3	2, 719	15. 3	15, 894	17. 6	4, 424	27. 5	5, 705	17. 1
2 to 3 tons	6, 006	3. 8	377	2. 1	3, 292	3. 7	718	4. 5	1, 619	4. 9
3 to 4 tons	3, 946	2. 5	166	. 9	2, 468	2. 7	249	1. 6	1, 063	3. 2
4 to 5 tons	4, 740	3. 0	53	. 4	3, 496	3. 9	150	. 9	1, 041	3. 1
5 tons and over	1, 770	1. 1	1	------	486	. 5	900	5. 6	383	1. 1

[1] In addition, there were registered in Massachusetts 1,426 trucks, owned by municipalities, the capacities of which were not recorded.

that has brought upon them, even in the sparsely settled rural sections, an intensity of traffic which demands for its adequate accommodation types of surface construction of much greater durability and cost than were required by the traffic of 20 years ago.

It is this change that has made necessary a continuous and consistently improved system of main roads covering the entire State and connecting with similar systems in the adjoining States. By virtue of the situs of ownership of the motor vehicles, their range of travel, and the character of their use, there comes naturally upon certain highways of Connecticut, as of all other States, a concentration or accumulation of traffic contributed by all sections of the State and adjoining States. These highways are those which should be included in the State highway system, to be improved to a degree consistent with their dense traffic. Others more numerous and more extensive in the aggregate, because of their location, serve no such heavy traffic and accommodate the vehicles of the locality rather than the larger area. These may reasonably be continued under the administration of the local officials. But, even on those highways which properly belong in the State system, there are different degrees of traffic density which call for different degrees of improvement.

As a result of the increase in license fees and the imposition of the gasoline tax the operators of the motor vehicles now pay upwards of 70 per cent of the revenue which is necessary to meet the gross highway expenditures of the State. They are therefore entitled to such an expenditure of the State's revenue as will produce the greatest benefit to the traffic. The State, on its own part, viewing the developing use of the motor vehicle as the development of a new form of transportation, is interested in the provision of highways of a character that will contribute to the development of the highest economy in this as in other forms of transportation.

The several changes which have been made during the period of motor-vehicle development in the program of highway improvement and in methods of highway administration, have been brought about mainly by this intention.

THE PROCESS OF ADJUSTING THE SERVICE OF HIGHWAY CONSTRUCTION AND REPAIR TO THE NEEDS OF TRAFFIC MUST BE CONTINUED, ESPECIALLY IN VIEW OF THE CHANGING CHARACTER OF TRAFFIC

This process of adjustment of the service of highway construction and repair to the needs of traffic must be continued, and it was for the purpose of ascertaining the facts necessary as a basis for the framing of a program for the immediate future that the Connecticut highway transportation survey was undertaken jointly by the United States Bureau of Public Roads and the State highway department.

THE TRANSPORTATION SURVEY

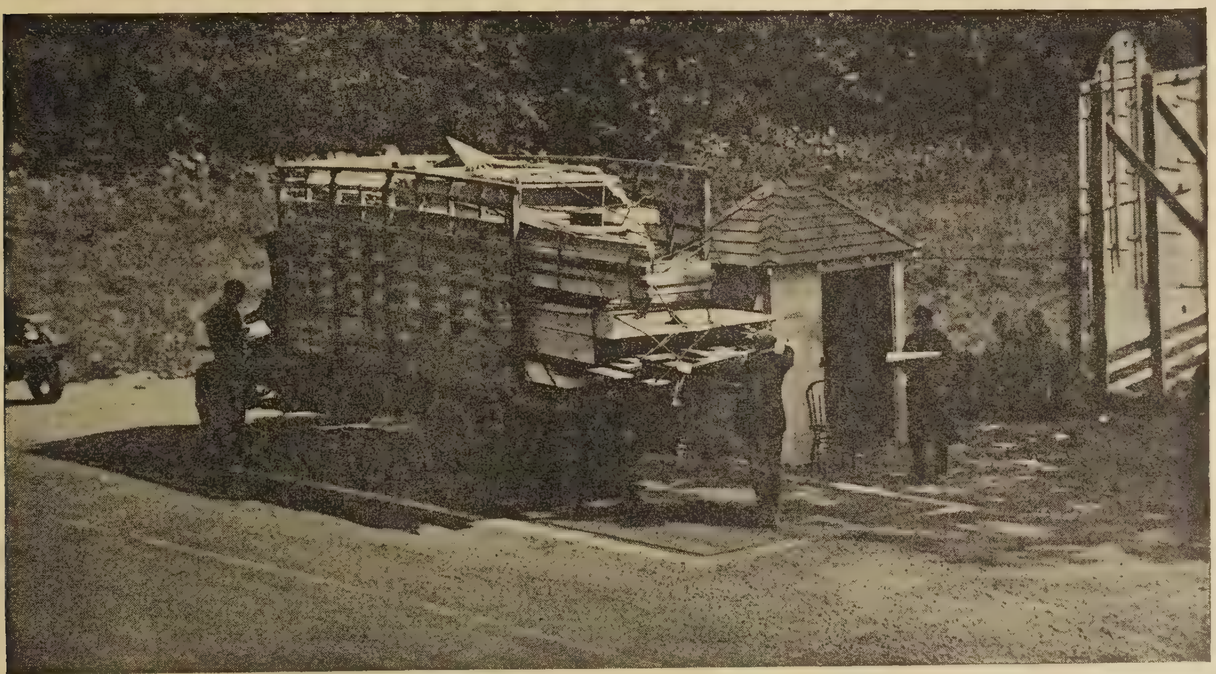
THE development and improvement of the Connecticut highway system increases the public welfare by the provision of highway transportation service. The justification of the program depends upon the extent and quality of the service provided, for there is no fundamental difference in principle between this public business of providing highway transportation facilities and a private business engaged in the production of commodities or the performance of services. The same basic principles of management govern in both cases.

Applied to the public business of providing highway transportation service, the first of these principles is that the mileage and type of the improved highways developed must be such as to meet the public demand and adequately serve the traffic needs.

The second is the familiar principle of the budget upon which all financially sound industries are founded. Applied to highway improvement it involves: (1) The determination of the amount of money required to effect the improvement; (2) the apportionment of the cost among those who benefit in proportion to the benefits received; and (3) the expenditure of the money in accordance with the predetermined plan under which each particular highway will be improved to the degree required by the traffic and to no greater degree.

Finally there are the principles of engineering and business management which govern the physical production of the improvement.

The highway engineer as the director of the public business of providing highway transportation service is responsible: (1) For the analysis of the demand for his product; (2) for

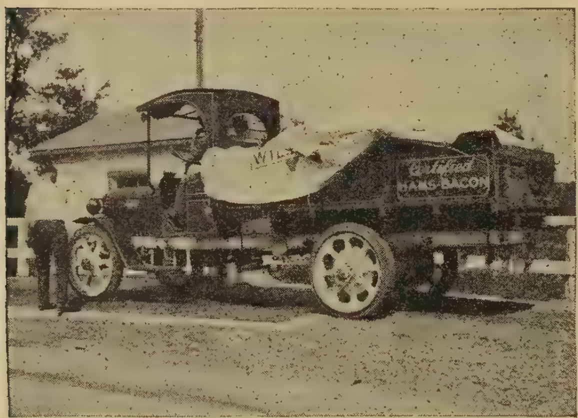


Measuring and Weighing a Load of Building Material at One of the Survey Stations

a financial analysis of the revenues required, the revenues available, and the establishment of a budget for the period of the improvement program; and (3) for the business management of the undertaking.

Efficient highway administration in accordance with these principles requires comprehensive economic and engineering research.

The tremendous increase in the number of vehicles has revolutionized highway transportation. It has made the provision of highway



TRAFFIC DATA WERE RECORDED AT 57 SURVEY STATIONS

service one of the principal industries of the country. Each year since 1920 expenditures for rural highways in the United States have approximated one billion dollars, and still highway construction has not kept pace with the demands for highway service as reflected by the growth of motor-vehicle registration and traffic.

The establishment of scientific plans of highway development, which will produce the maximum of highway service with the available revenues and the available supply of labor, equipment, and building materials, requires a careful analysis of highway traffic, the trend of its development, and its distribution over the highway system. The necessity of such an analysis is now recognized by highway executives throughout the country, but their efforts have been handicapped by the lack of precise knowledge of the character and amount of the traffic using the various roads. It was to remove this handicap and to provide a basis for the scientific planning of highway improvements in Connecticut, that this systematic and comprehensive study of highway traffic was undertaken.

The general purpose of the survey was to obtain the traffic information necessary for the establishment of a definite plan of highway improvement based on the present and expected future traffic significance of the various highways in the State.

A classification of all highways on the basis of their relative traffic importance was felt to be the first need. Such a classification is required to determine the order in which the highways should be improved and the distribution of construction and maintenance funds over the highway system.

The order of improvement thus established, and an equitable allocation of funds provided, the selection of the most economical type and design of improvement for each highway is the next step. Such a selection must be based not only upon the present and expected future traffic density but also upon the type of the traffic units. The more important considerations are: (1) The present and estimated future density of traffic; (2) the ratio of the number of trucks to the number of all vehicles; (3) the relative number of trucks of large, medium, and small capacities; and (4) the maximum wheel loads and the frequency of heavy gross loads and wheel loads.

In individual cases other factors must be considered, but in general these considerations govern the selection of types and the design of the pavements. The final selection of the type of surface depends also upon physical considerations such as topography, drainage, soil and subgrade conditions, availability and cost of materials, as well as upon traffic considerations.

In addition to these purposes it was also planned to determine the place of highway transportation in the transportation system as a whole, and to establish the principles which should form the basis for the coordination of highway transportation with other forms in order to develop as a whole the most efficient transportation system.

THE METHODS OF THE SURVEY

THE survey was begun in September, 1922, and continued for one year, during which time traffic data were recorded at the 57 survey stations shown in Figure 10. These stations, carefully located and designated before the beginning of the survey, were operated on an average of once a month by "recording" parties which recorded all passenger-car information and the principal types of motor-truck information, with the exception of the weights of the vehicles. Nine hours constituted the length of each operation at a station; the actual hours, however, varied with each operation and ranged between 6 a. m. and 9 p. m. A sufficient number of night operations were made to enable the correction of all traffic counts to an average 24-hour day.

In addition to the operation by recording parties, 8 of the 57 stations were operated by a "weight" party, which recorded all motor-truck traffic information, including weights of vehicles. These eight stations were located at key points on the principal highways in different sections, in order that practices in motor-truck loading in various parts of the State could be determined.

The weight stations were operated for a period of one week (not including Sunday) every two months. The hours of operation ranged from 6 a. m. to 8 p. m., with a 10-hour operation, beginning at a different hour each day of the one-week period. Night traffic (between 8 p. m. and 6 a. m.) was recorded once during each week's operation at a station.

One of the most important features necessary for the efficient and successful procedure of the survey was a carefully planned field operating schedule. This schedule not only provided for the weekly operation of weight stations every two months and for a regular movement of recording parties from one station to another each day, but also for a proportionate number of Saturday, Sunday, and week-day operations at each station. The schedule also provided for the recording of traffic at a different period of the day each time a station was operated; in this way it was possible to determine variations in traffic during an entire day. It was also necessary, in devising the field-operating schedule, to avoid duplicate recording of traffic which would result if two or more survey stations, located near each other on the same highway or on connecting highways, were operated on the same day.

Fig. 10.—Location of Connecticut Traffic Survey Stations

The forms used by recording parties in recording motor-truck and passenger-car data and the record sheet used by the weight party in recording motor-truck information are shown in Figures 11 and 12.

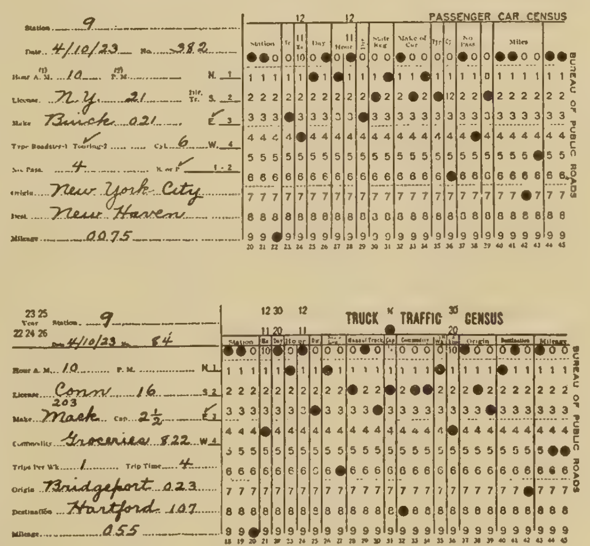


Fig. 11.—Reproduction of Tabulation Cards Used in Traffic Survey

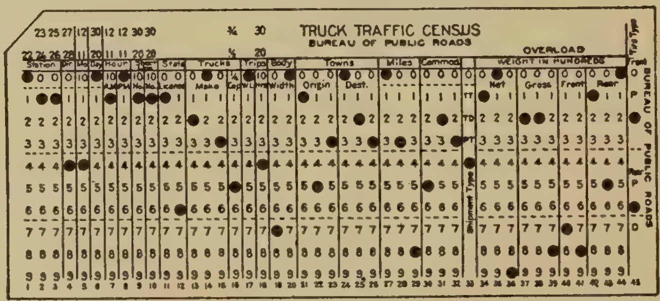
CONNECTICUT — TRAFFIC SURVEY

UNITED STATES BUREAU OF PUBLIC ROADS

TRUCKS DATE April 10 '23 STATION New Haven 11 DIRECTION OF TRAFFIC West SHEET NO. 1

TIME A.M.	LICENSE NUMBER	MAKE	CAPACITY	TRIPS PER WEEK	TRIP TIME	LOAD OR EMPTY	WIDTH OF BODY	CODED INFORMATION: ORIGIN	CODED INFORMATION: DESTINATION	CODED INFORMATION: MILEAGE	CODED INFORMATION: COMMODITY	CODED INFORMATION: TYPE OF SHIPMENT	WEIGHTS: NET WEIGHT	WEIGHTS: GROSS WEIGHT	WEIGHTS: FRONT AXLE	WEIGHTS: REAR AXLE	TIRE WIDTH ON PAVEMENT UNDER LOAD: FRONT WIDTH	FRONT TYPE	REAR WIDTH	REAR TYPE	DEPTH CHANNEL TO PAVEMENT UNDER LOAD: FRONT	REAR	WIDTH CHANNEL TO CHANNEL: FRONT	REAR
10	^{16}C 10349	Mack 203	5	0	4	L	7.0	153	023	038	523	4	10920	22820	7760	15060	3.5	S	10	S	2.2	2.6	6	12
	^{16}C 38514	White 359	3½	12	1	L	6.0	156	156	009	451	2	8000	18300	5490	12810	3.0	S	8.8	S	1.5	2.5	5	10
	^{16}C 4387	Reo 274	1¼	6	1	L	5.6	105	105	020	284	4	1160	4860	1960	2900	—	P	—	P				
	^{21}N.Y. 105-759	Packard 256	5	3	12	L	7.2	107	107	113	961	1	11520	23320	6400	16920	—	P	9.8	D	—	2.6	—	12
	^{16}C 29437	Autocar 016	2	6	1	L	5.7	156	156	014	713	4	2680	7880	3680	4200	—	P	—	P				
	^{14}B 39412	Pierce-Arrow 262	3½	0	36	L	7.2	423	423	244	601	4	6280	16680	5880	10800	—	P	—	P				
	^{16}C 22241	Ford 116	1	3	1	L	5.3	156	156	018	145	4	2380	4780	1160	3620	—	P	—	P				
	^{16}C 23421	Dodge 088	½	0	4	E	5.4	133	133	061	000	0												
	^{16}C 15375	G.M.C. 133	2	6	3	L	6.5	156	156	040	822	2	4800	11200	2920	8280	2.9	S	5.5	D	1.6	2.5	4	8
	^{16}C 32429	Federal 115	5	3	14	L	7.0	158	158	129	998	3	9380	20180	3780	16400	3.5	S	9.5	S	1.8	2.2	6	12

INTENSIVE TRUCK TRAFFIC CENSUS TABULATION CARD



CONNECTICUT — TRAFFIC SURVEY

UNITED STATES BUREAU OF PUBLIC ROADS

TRUCKS DATE April 10 '23 STATION New Haven 11 DIRECTION OF TRAFFIC West SHEET NO. 1

TIME A.M.	LICENSE NUMBER	TRUCK OWNER	SHIPPER: NAME	SHIPPER: CITY	SHIPPER: STATE	DESTINATION OF SHIPMENT: NAME	DESTINATION OF SHIPMENT: CITY	STATE	CLASS OF SHIPMENT P.D. T.T. P.T. D.T.	COMMODITY	PACKING AND CRATING
10	C 10349	Richards & Sons	Smith Co.	Meriden	C.	Jones Foundry	Bridgeport	C.	P.D.	Brass Tubing	Loose
	C 38514	Gulf Refining Co	" "	New Haven	C.	Various	Milford	C.	T.D.	Gasoline	Tank Truck
	C 4387	Oakland Farm	" "	Hamden	C.	"	Stratford	C.	P.D.	Milk	Bottles in cases
	N.Y. 105-759	Merchants Line	Underwood	Hartford	C.	New York	Pier, N.Y.	N.Y.	T.T.	Typewriters	Wooden cases
	C 29437	Acme Bakery	"	New Haven	C.	Various	Stratford	C.	P.D.	Bread	Hampers
	B 39412	Warren Bros.	H. B. Brown	Boston	Mass	H. B. Brown	Newark	N.J.	P.D.	Household Goods	Padded
	C 22241	Tony Bruno	"	New Haven	C.	"	Bridgeport	C.	P.D.	Vegetables	Crated
	C 23421	Hayes Bros.		Madison	C.		Danbury	C.		Empty	
	C 15375	Gray Bros.	"	New Haven	C.	Various	Stamford	C.	T.D.	Groceries	Bbls. Boxes & Bags
	C 32429	Red Star Line	Various	New London	C.	Cunard Line	New York	N.Y.	P.T.	Personal Effects	Boxes & Bales

FIG. 12.—FIELD FORMS USED FOR RECORDING PASSENGER CAR AND MOTOR TRUCK DATA AT RECORDING STATIONS

DENSITY OF HIGHWAY TRAFFIC

THE average daily distribution of traffic on the important highways of Connecticut, as developed by the survey, is shown in Figure 13, in which the width of the lines representing the roads is proportioned to the observed average and maximum traffic density. It is apparent that the Boston Post Road from the New York line near Greenwich to New Haven is the most important highway in the State. Of almost equal importance is the highway extending north from New Haven through Meriden, Hartford, and Thompsonville to the Massachusetts line. Other important main routes are the highways from Bridgeport to Waterbury and Thomaston, Thomaston to Hartford, the shore route from New Haven to New London and Westerly, and the route from New London to Norwich, Plainfield, and Putnam.

The traffic importance of the above-mentioned routes is explained by the fact that they connect the important centers of population and industry in Connecticut and neighboring States. The route from Greenwich to New Haven is the most important highway in the State system, partly because it is the natural inlet and outlet for New England traffic and provides the main highway connection between New York City, which is located approximately 30 miles southwest of Greenwich, and the Bridgeport and New Haven territory, and partly because of the large number of smaller towns and villages through which it passes. As distance from a large city increases it has been found to be the general rule that traffic originating at or destined for that city decreases. In the case of the route from Greenwich to New Haven, the expected decrease in

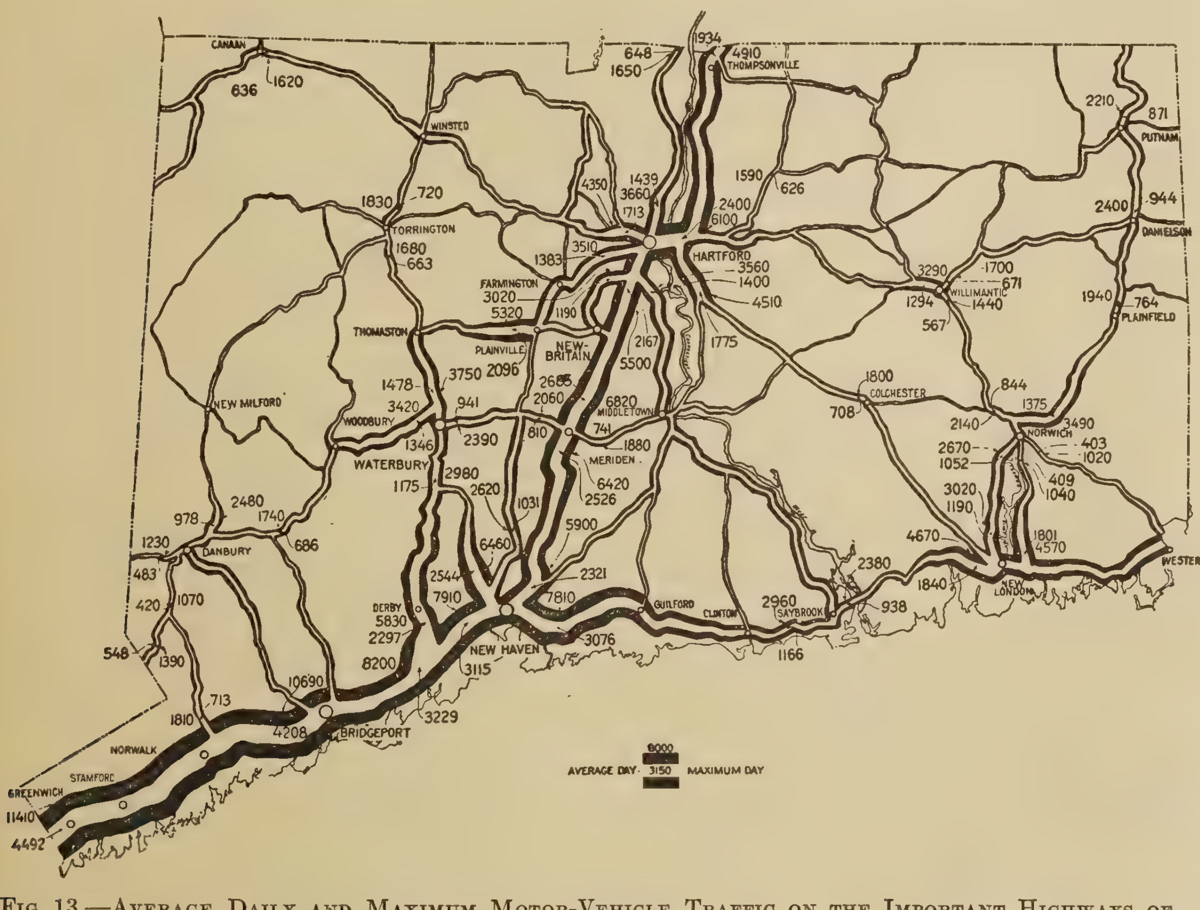


FIG. 13.—AVERAGE DAILY AND MAXIMUM MOTOR-VEHICLE TRAFFIC ON THE IMPORTANT HIGHWAYS OF CONNECTICUT

traffic with increasing distance from the larger cities is largely offset by the increments of traffic from smaller cities and villages along the route. This results in very uniform density throughout the route. On the shore route from New Haven to Westerly the variation in traffic density is much greater, decreasing as it does from an average of over 3,000 motor vehicles east of New Haven to less than 1,000 vehicles a day at the Connecticut River bridge east of Saybrook.

The effect of proximity to the larger cities upon traffic density is apparent on other roads entering New Haven, particularly on the road from New Haven toward Waterbury, on the roads leading to Hartford, and on roads leading to New London. On most of these roads the traffic decreases rapidly as the distance from the city increases. Naturally, when cities are only a short distance apart, zones of influence overlap and the highway traffic between them becomes relatively uniform at all points. This condition is observable on the routes connecting Hartford with New Britain, with Farmington, with Plainville, and with Bristol, which is located approximately 5 miles west of Plainville.

It is generally true, however, that traffic on any route decreases as distance from the centers of population served by the route increases, and the point of minimum traffic is therefore the point farthest removed from the centers of population. In general, the traffic tends to vary directly with the population and industry served by the route, and inversely as the distance from centers of population and industry. Other factors prevent the development of an accurate mathematical formula, but the tendency is pronounced.

With the exception of the route from Greenwich to Westerly, the general direction of the important traffic routes in Connecticut is north

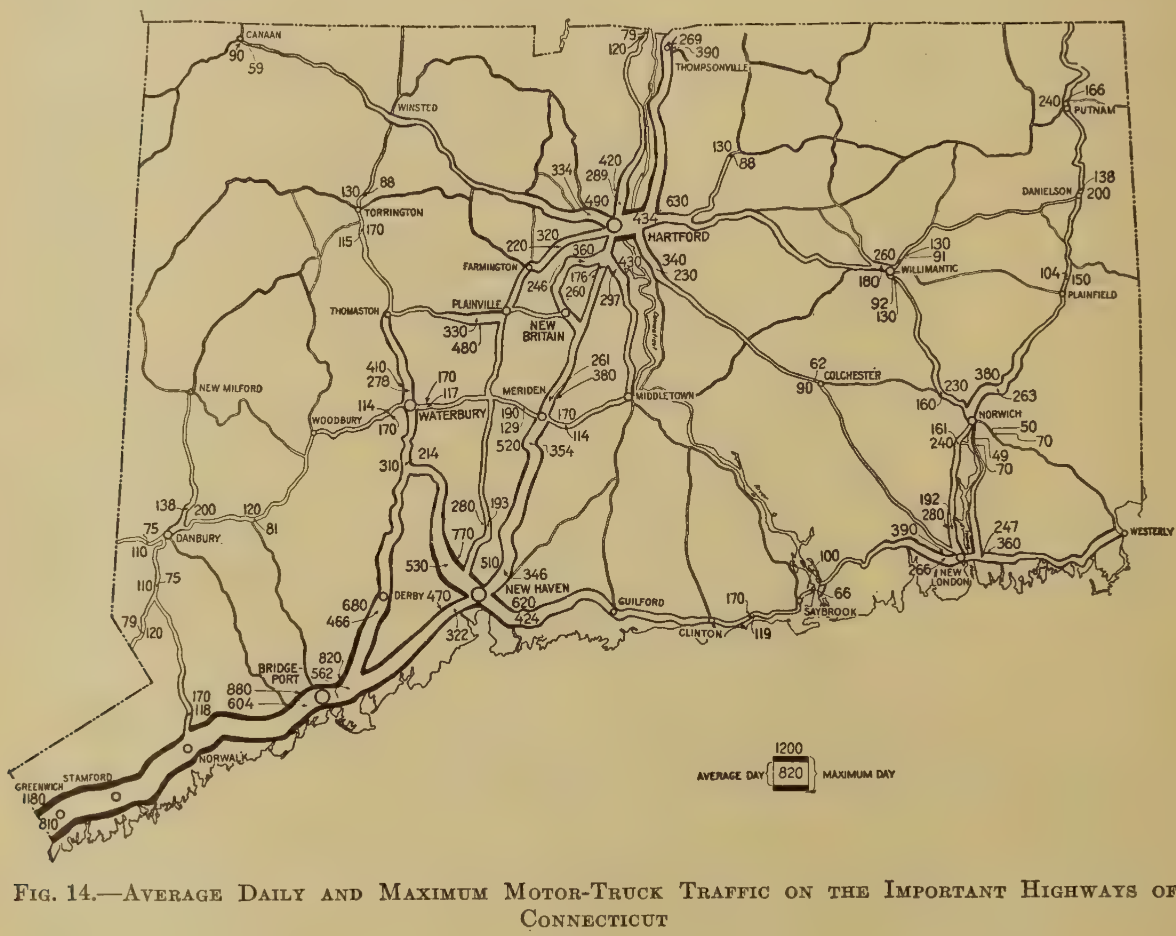
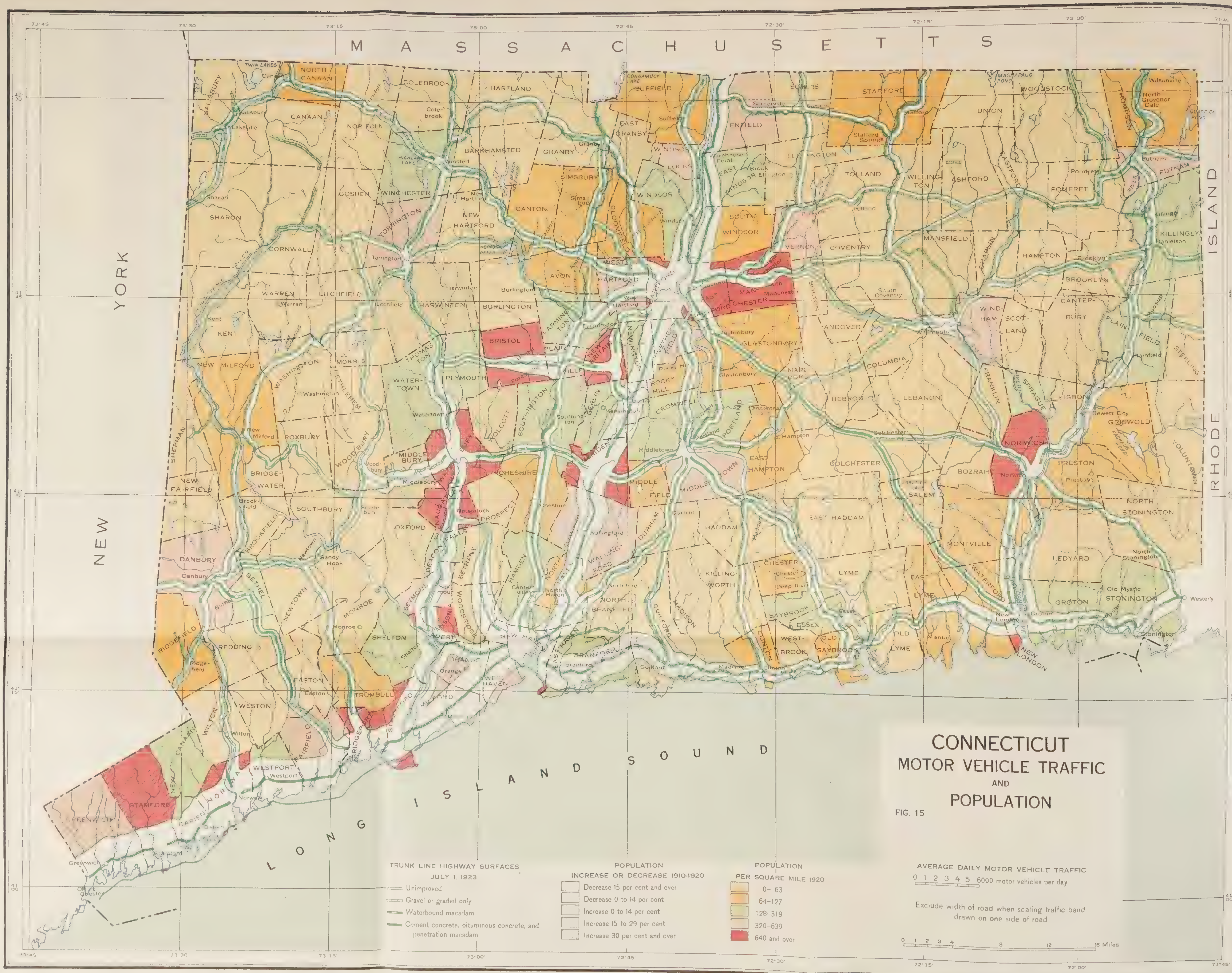


Fig. 14.—Average Daily and Maximum Motor-Truck Traffic on the Important Highways of Connecticut



MASSACHUSETTS
NEW YORK
RHODE ISLAND
LONG ISLAND SOUND
CONNECTICUT
MOTOR VEHICLE TRAFFIC
AND
POPULATION
FIG. 15
TRUNK LINE HIGHWAY SURFACES
JULY 1, 1923
Unimproved
Gravel or graded only
Waterbound macadam
Cement concrete, bituminous concrete, and penetration macadam
POPULATION
INCREASE OR DECREASE 1910-1920
Decrease 15 per cent and over
Decrease 0 to 14 per cent
Increase 0 to 14 per cent
Increase 15 to 29 per cent
Increase 30 per cent and over
POPULATION
PER SQUARE MILE 1920
0– 63
64–127
128–319
320–639
640 and over
AVERAGE DAILY MOTOR VEHICLE TRAFFIC
0 1 2 3 4 5 6000 motor vehicles per day
Exclude width of road when scaling traffic band drawn on one side of road
0 1 2 3 4 8 12 16 Miles

and south. Other east and west routes, although of considerable importance, are secondary to the north and south routes.

The distribution of average daily truck traffic shown in Figure 14 is, in general, similar to the distribution of total traffic. The routes from Greenwich to New Haven, New Haven to Hartford and Thompsonville, Bridgeport to Waterbury and Thomaston, Thomaston to Hartford, New Haven to New London and Westerly, and New London to Norwich, Plainfield, and Putnam, already shown on the basis of the total traffic to be the most important highways in the State, are shown by Figure 14 to be the most important motor-truck highways. Other routes connecting important industrial centers, such as New Haven and Waterbury, and Hartford and New Britain, are of greater relative significance as trucking routes than as passenger-car routes.

The width of the white space between the black lines of Figures 13 and 14 represents the average daily traffic throughout the year. But traffic varies greatly with the seasons of the year and the days of the week. Hence there is also shown in these figures by the width from outside to outside of the bordering black lines the maximum traffic which occurs at all points at certain periods. Considering all types of vehicles, Sunday is the day and August the month of maximum total traffic. The distribution of the total traffic on a Sunday in August is therefore presented in Figure 13 as an indication of the maximum traffic density. The density of the traffic on this particular day was 254 per cent of the average.

Variation in truck traffic is considerably less than the variation in passenger-car traffic. The monthly variation in passenger-car traffic ranges from 29 to 193 per cent of the average. For truck traffic the corresponding range is from 68 to 122 per cent. Truck traffic is very uniform from Monday through Friday. On Saturday it is somewhat lower than on other week days, and on Sunday it is very low compared with other days of the week.

Maximum daily truck traffic, as shown in Figure 14, which represents a Friday in October, is approximately 146 per cent of the average daily truck traffic for the year. These figures represent the present normal peak load of traffic for which highway facilities are required. Unusual density of traffic on holidays or special movements on certain routes due to fairs, football games, and similar events will exceed in density the movements indicated on these charts. It is not necessary to consider these special movements in planning the highway program, but due allowance must be made for the expected increase in traffic during a reasonable period in the future.

The highways which, on the basis of average traffic, are the most important traffic routes, as shown by Figure 13, are also the most important highways from the point of view of maximum traffic. The highway from Greenwich to New Haven carried during a Sunday in August approximately 8,000 vehicles throughout its entire length, and near Greenwich a total of 11,410 vehicles. The highway from New Haven to Hartford served during the same period between 5,500 and 6,800 vehicles throughout the entire distance, and the continuation of this highway through Thompsonville to the Massachusetts line served approximately 5,000 vehicles during the maximum day.

In Figure 15 the average daily traffic on the State highways is shown in relation to the density of population and the increase or decrease in population during the last decennial period. (See Appendices V and V–A). It is evident from this figure that the principal traffic routes are as follows:

1. The Post Road from the New York State line through Bridgeport, Meriden, Hartford, and Thompsonville to the Massachusetts line.
2. The route from Bridgeport to Torrington.
3. The Shore Road from New Haven to Westerly.
4. The route from New London to Putnam.
5. The route from Hartford through Farmington and Plainville to Thomaston.
6. The route from Hartford to New Britain and Plainville.
7. The route from New Haven to Waterbury.

It is evident also from the grouping of the areas of dense population about the important traffic routes that there is a relation between highway traffic and the population of the tributary area.

Of the 17 towns having a population in 1920 of 640 or more persons per square mile, 16 are traversed by these principal highways, and the remaining town, Manchester, is located east of and connected with Hartford by a heavy traffic route.

Of the 34 towns having a population in 1920 of 320 or more persons per square mile, 28 are traversed by the above routes; and of the remaining 6 towns, 4 (Danbury, Middletown, Vernon, and Windham) include incorporated cities which contain the major part of the population of the town. The remaining towns are Manchester, mentioned above, and Windsor Locks, a town of very small area.

Of the 62 towns having a population in 1920 of 128 or more persons per square mile, 45 are traversed by these principal highways. In addition to the 6 mentioned above, towns in this group not traversed by these highways are Winchester, including the city of Winsted; Southington, including the borough of Southington; Bethel, including the unincorporated borough of Bethel, which in 1910 as the borough of Bethel contained 80 per cent of the population of the town; Hamden, which is adjacent to New Haven; Essex; Sprague; Cromwell; Windsor; New Canaan; Saybrook; and Portland.

Of the 106 towns having a population of less than 128 persons per square mile in 1920, only 15 are traversed by the principal highways, and 8 of these 15 towns are adjacent to the Shore Road. Reference to Figure 15 will indicate that traffic on the section of this route passing through these towns (Guilford to Westbrook, inclusive) is small as compared with the traffic on the rest of the route.

Of the 80 towns having a population of less than 64 persons per square mile in 1920, only 8 are traversed by the principal highways. These towns are Harwinton, on the Bridgeport-Torrington route; Bethany and Woodbridge, on the New Haven-Waterbury route; Old Lyme, Madison, Westbrook, and Guilford, on the Shore Road; and Lisbon, on the New London-Putnam route.

The areas adjacent to the important routes are also increasing in population at a more rapid rate than the other sections of the State. Of the 35 towns having an increase in population of 30 per cent or more between 1910 and 1920, as shown by Figure 15, 24 are traversed by the main highways. Of the remaining 11 towns which increased 30 per cent or more, only 1—Manchester—had a population of over 320 people per square mile in 1920.

Of the 59 towns having an increase in population of 15 per cent or more during the same period, 40 are traversed by these routes. Of the remaining 19 towns which increased 15 per cent or more, only Manchester had a population of over 320 people per square mile in 1920.

A summary of the population density and rate of increase in the areas adjacent to the principal traffic routes is shown in Table 16,

The areas adjacent to each of the principal routes have an average density of population per square mile considerably in excess of the

Table 16.—Comparison of town population per square mile and rate of population increase or decrease in areas adjacent to Connecticut highways

Towns traversed by—	Population per square mile, 1920	Percentage of increase, 1910 to 1920	Number of towns	Number of towns increasing	Number of towns decreasing
Boston Post Road	1, 288	34. 0	22	20	2
Bridgeport-Torrington route	1, 256	33. 9	14	14	0
New Haven-Waterbury route	2, 568	22. 7	5	4	1
Hartford-Farmington-Thomaston route Hartford-New Britain-Plainville route	1, 683	39. 0	8	8	0
Shore Road-New Haven to Westerly	642	21. 9	14	9	5
New London-Putnam route	376	17. 2	8	8	0
All other towns	82	4. 7	108	46	62
State	286	23. 9	168	98	70

average for the State. The area adjacent to the New Haven-Waterbury route shows the greatest density of population. This route is short and connects the important cities of New Haven and Waterbury. Traffic between these points has three alternative routes—the direct route, the route via Derby, and the route via Cheshire—so that motor-vehicle movement on the direct route is not so heavy as the population would indicate.

Population is also increasing at a faster rate in the areas adjacent to the principal traffic routes, the rate of increase varying from 17.2 to 39 per cent, while the rate of increase for the remainder of the State is only 4.7 per cent. The more rapid rate of population increase in the areas adjacent to the principal highways indicates the urgent need for the planning and construction of highways to serve future traffic needs in these areas.

The growth of population is not uniform along the various routes. The Post Road traverses two towns which decreased in population between 1910 and 1920, and the Shore Road traverses five towns which decreased during the same period. In each of these cases the increase in population along other portions of the route overshadows these decreases so that, although the traffic originating in these towns may be decreasing, the traffic on the route will continue to increase.

The present distribution of population and the trends of population growth as reflected in the more rapid increase in the densely populated areas and in the more rapid increase in urban population than in rural population indicate that the present main traffic routes will continue to be the important routes and may increase in relative importance. The changes in relative importance of main traffic routes, as compared with those of secondary importance, must of necessity be slow and will not be important during the next few years.

The present trends indicate that minor traffic routes will with some exceptions continue to be of minor importance. The present areas of low population density and of decreasing or slowly increasing population will not become important traffic areas during the next decade. These areas are particularly the northwestern part of the State and the area north of Willimantic, east of the territory served by the Post Road from Hartford to the Massachusetts line, and west of the territory served by the highway leading from Putnam to the Massachusetts line.

PROVISION FOR DENSE TRAFFIC ON CERTAIN HIGHWAYS

The provision of safe and adequate highway facilities for the volume of traffic using the principal highways becomes a problem of the first magnitude. Safety demands a width of highway, throughout the entire route, adequate to accommodate the traffic. Any obstruction which impedes the free flow of traffic, such as dangerous curves, sharp grades, narrow bridges, highway and railway intersections at grade, and traffic "bottle necks," becomes a point of congestion and danger. Within villages and cities, through which a heavy-traffic route passes, trolley lines, narrow or inadequately improved streets, congestion caused by the parking of automobiles, and traffic at intersecting streets add to the difficulties of the problem of providing adequate highway service.

Economy and efficiency of highway transportation, as well as safety, require the elimination of all obstructions to the free movement of traffic. When the traffic is dense, delays caused by obstacles to its continuous and uniform movement add largely to the cost of moving people and commodities over the highways. A small differential in the cost of operating vehicles over different types of surface accumulates to large losses to the motor vehicle users on a heavy-traffic route, unless the highway is improved with the type of surface which provides the greatest economy in vehicle operating costs.

It is clearly sound economic and engineering policy, therefore, where the daily traffic volume is large, to provide highway service over the most direct practicable route, with low gradients, and adequate width, with the type of surface upon which vehicle operating costs are the lowest, and with every possible obstruction to the free flow of traffic removed.

The routing of an important highway through a large city also creates other problems. The traffic volume is always greater at

the entrances to the city and within the city than it is upon the highway at some distance from the city limits. This congestion is due primarily to the large volume of local and suburban traffic which is added to the interurban traffic, and to the fact that frequently two or more highways converge at or near the entrance to the city. It is possible, but frequently very difficult, to provide additional highway capacity by the diffusion of the traffic flow into several parallel streets and by eliminating the convergence of highways at one city entrance. In the majority of cases it will probably be found to be in the interests of both economy and safety to construct "by-pass" routes around centers of population which will enable through traffic to avoid the city and also permit the natural "sorting" of traffic outside the congested city area. It is doubtful if the additional business which accrues to a limited class as a result of routing through traffic through a city is commensurate with the inconvenience and danger to normal local vehicular and pedestrian traffic resulting from traffic congestion in the city streets.

Another possible solution of the problem of providing adequate and safe highway service on the Greenwich-New Haven route is to develop a parallel route a few miles north of the present location. In this way a number of the present congestion points could be avoided and a direct route for through traffic, with connections to all important cities and villages, could be provided. The forecast of traffic for 1930 indicates that the satisfactory handling of traffic on the present route will soon become a serious problem. A parallel route north of the present one would provide a fast-traffic highway, avoiding some of the traffic problems involved in passing through villages, and would have in addition two distinct advantages. It would open and develop another section of the State and, by a shift of through traffic from the present route, permit local traffic to utilize to full advantage the present location.

The solution of this problem should be based upon the relative cost of the various improvement plans as compared with the service yielded by the improvement.

TRAFFIC DENSITY IN RELATION TO PRESENT SURFACES

Figures 16 and 17 indicate, respectively, average density of daily total vehicle and motor-truck traffic in relation to the types of surfacing with which the highway system was improved in 1923. In general, it will be noted that the principal traffic routes are surfaced with the higher types of surfaces. There is, however, a lack of uniformity of type on many of the important routes. For example, the highways from Greenwich to New Haven and from New Haven through Hartford and Thompsonville to the Massachusetts State line, although principally of concrete construction, have sections of macadam surfacing. On these routes this latter type of surfacing will not provide adequate service without excessive maintenance expense.

The Shore Road from New Haven to Westerly is largely of macadam construction although there are short sections of concrete. On sections of this route, particularly from New Haven to Guilford and near New London, macadam surfacing is inadequate. This route also has a section of gravel near Saybrook which can not be expected to yield adequate service without excessive maintenance costs.

The route from the junction with the Post Road east of Bridgeport to Derby, Waterbury, and Torrington is almost entirely of concrete construction except for the gravel section between the Post Road and Derby. This section undoubtedly does not provide adequate service to the volume of traffic using the route. The route from New London to Norwich, Plainfield, and Putnam has a large mileage of gravel surface, which can not provide adequate service, particularly in view of the volume of heavy-duty truck traffic found on sections of this highway. (Fig. 20.) The road from New Haven to Waterbury also carries heavy traffic, both passenger-car and truck, in proportion to its type of construction.

The most important light traffic route which is improved with high-type surface is the highway from Hartford to New London via Colchester. High-type surfaces on other light

traffic routes are generally limited to short sections.

The relation of present traffic density to the types of existing highway improvement, as shown in Figures 16 and 17, together with the capacity of the motor trucks using the roads, motor-truck loading practices, and the expected future traffic upon various routes, as analyzed in following sections of this report, are among the more important factors to be considered in the formulation of a scientific program of highway development.

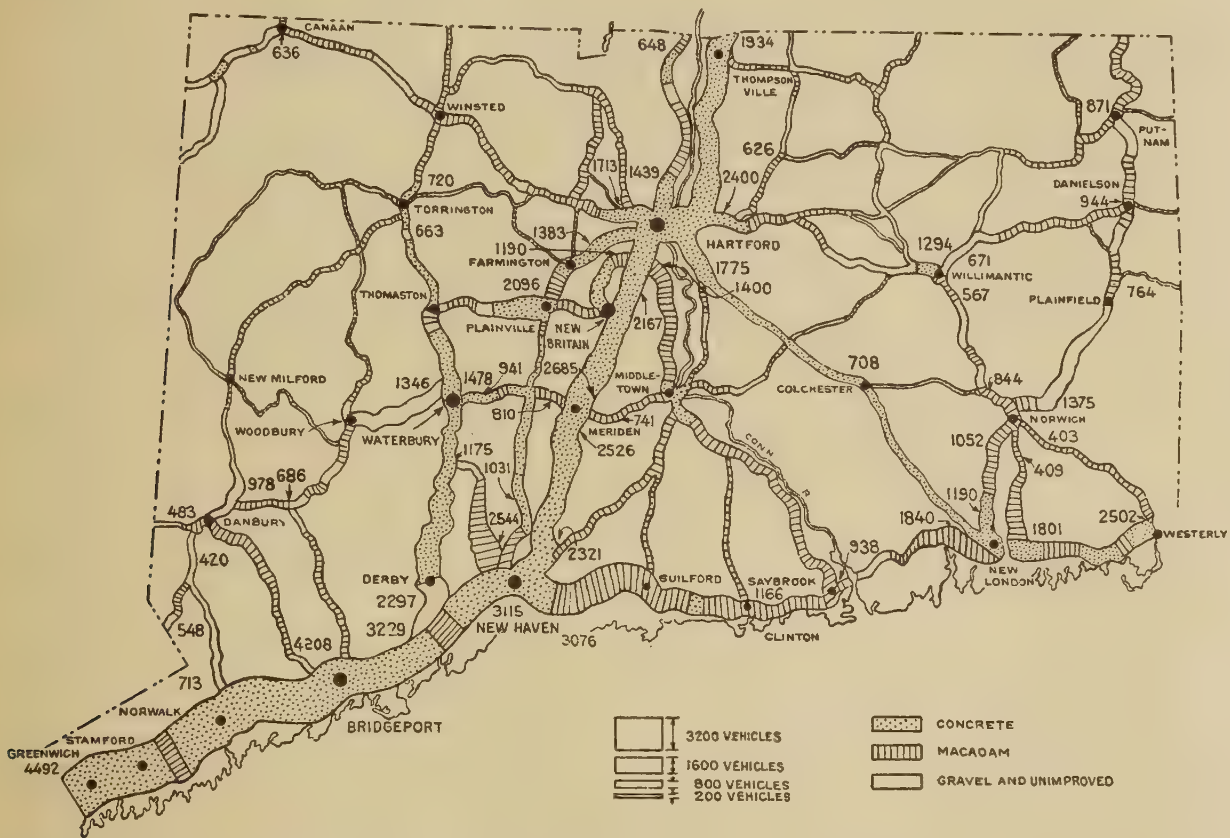


FIG. 16.—AVERAGE DAILY TRAFFIC OF PASSENGER CARS AND TRUCKS IN RELATION TO EXISTING TYPES OF ROAD

MOTOR TRUCK CAPACITIES AND LOADING

THE design of highways and the type of pavement used for their improvement are dependent not only upon the amount of traffic using them but also upon the type and the weight of the traffic. The amount of traffic, or the number of vehicles using the various routes, indicates the general traffic importance of one highway compared with another. The number of vehicles is the most important factor to be considered in problems of highway width, in the construction of parallel routes, in the elimination of grade crossings, in the elimination of traffic "bottlenecks," and in similar problems concerned primarily with the free movement of traffic. But the determination of the amount of traffic does not form sufficient or conclusive evidence for the final selection of highway design and type of pavement, to serve traffic adequately and economically.

Analysis of traffic on the Connecticut roads reveals entirely different types of traffic on

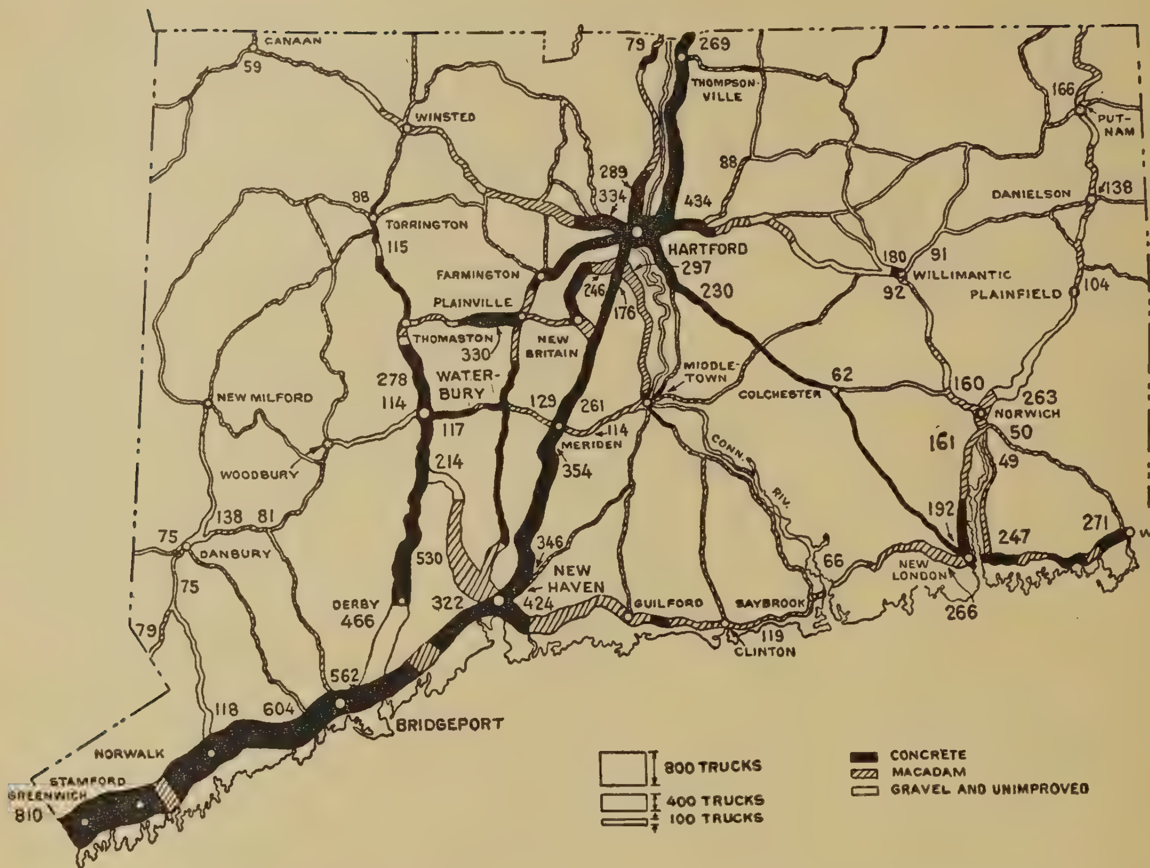


Fig. 17.—Average Daily Motor-Truck Traffic in Relation to Existing Types of Road

various highways. The first difference noted is a higher proportion of motor-truck traffic on one highway than another. This can be illustrated in the case of two highways, one of which connects two large industrial centers and the other a city and a pleasure resort. The latter highway would naturally be mainly a passenger-car route and be used less by motor-truck traffic (in proportion to total traffic) than the route connecting industrial centers. A more searching analysis reveals variation in motor-truck traffic itself; a preponderance of large-capacity trucks and heavy gross loads on one route and of small-capacity trucks and light gross loads on another.

Highways are affected not only by the number of vehicles passing over them but also by the types of these vehicles. Variation in the capacity, loading, and tire equipment of the vehicles causes corresponding variations in the effect upon the highways. Light, pneumatic-tired vehicles have less effect then heavy, solid-tired vehicles. An investigation by the United States Bureau of Public Roads, into the effect of motor-truck impact upon highways, shows that a badly worn solid tire can deliver an impact seven times as great as the static wheel load. Pneumatic tires, on the other hand, seem to definitely limit the impact. In no case, using obstructions as high as 4 inches, has it been possible to record pressures under pneumatic tires greater than double the static weight.[13] In the choice of the design and type of pavement, therefore, these variations in type of traffic must be considered.

Variations in the rated capacities of motor-trucks using highway routes are an excellent basis for determining the type of motor-truck traffic. Small-capacity trucks are designed to carry light loads and although overloading (loading beyond the rated capacity of the truck) is not uncommon, it can not be prac-

[13] Status of the Motor Truck Impact Tests of the Bureau of Public Roads by C. A. Hogentogler, Public Roads, vol. 5, No. 9, p. 14.

ticed beyond a certain degree. The rated capacity of a truck is found to bear a close relation to the average load transported by it; and the capacities of all trucks using a highway will bear a similar relation to the tonnage transported over the highway. The proportion of light, medium, and heavy trucks passing over the highways of a State is the primary factor in the determination of types of motor-truck traffic.

Additional evidence concerning motor-truck traffic is obtained by an analysis of net and gross loads and of rear-axle and wheel loads. This evidence is not only valuable in the selection of highway design and type of pavement but also in traffic control and the regulation of overloading.

ANALYSIS OF MOTOR-TRUCK TRAFFIC ON THE BASIS OF CAPACITY OF VEHICLES

One-half ton is the predominant capacity of motor trucks using the Connecticut highways, approximately one-fourth of all trucks recorded during the survey being of that size. Most important, however, from the standpoint of the weight and number of the vehicles, is the 5-ton capacity, which was represented in the traffic by one-tenth of the total number of trucks. Table 17 shows relatively the number of motor trucks of all capacities observed in the State as a whole during the survey period. It is interesting to compare these percentages of the several capacities actually observed on the highways with the percentages of the same capacities registered as given in Table 15. It will be observed that the trucks of 1 ton capacity and under represent on the highways a much smaller percentage of the total traffic than they do of the total registration, while all other capacity groups are present in greater proportion in the traffic than in the registration lists. It is apparent, however, from Table 17 that, in the State as a whole, the motor-truck movement consists very largely of small-capacity trucks, although the heavy-truck movement is much heavier than the registration of such trucks would indicate. (Fig. 18.)

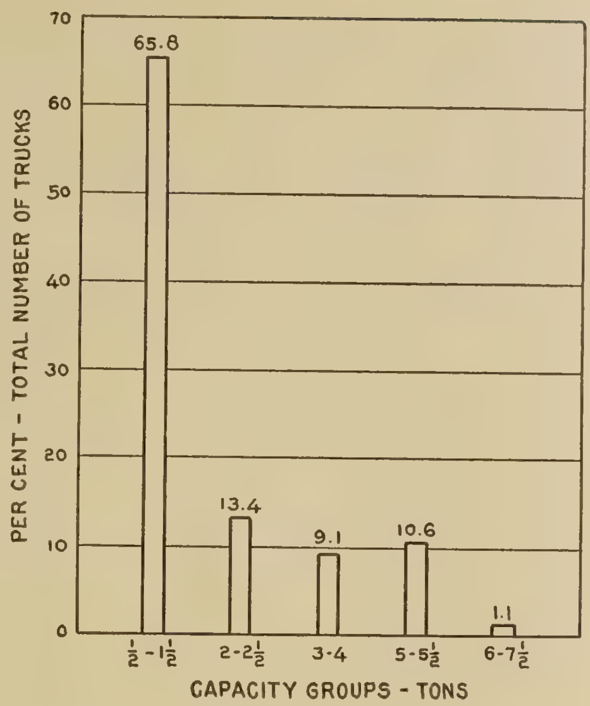


FIG. 18.—DISTRIBUTION OF MOTOR TRUCKS BY CAPACITY GROUPS

Table 17.—Distribution of observed motor trucks by capacity [1]

Capacity of trucks	Percentage of total number of observed trucks	Capacity of trucks	Percentage of total number of observed trucks	Capacity of trucks	Percentage of total number of observed trucks
Tons	*Per cent*	*Tons*	*Per cent*	*Tons*	*Per cent*
½	25. 1	2	9. 7	5	10. 2
¾	3. 8	2½	3. 7	5½	. 4
1	18. 4	3	1. 7	6	. 3
1¼	12. 5	3½	6. 7	6½	. 6
1½	6. 0	4	. 7	7½	. 2

[1] Based on 82,738 trucks.

That the distribution of light and heavy trucks varies considerably on highways in different areas of the State is indicated by the table in Appendix VI. The classification by capacity groups of the motor trucks observed at the various survey stations makes possible a comparison of the types of trucking at these stations and on the highways on which they are located. The highest percentage of large-capacity trucks was observed at station 36, located north of Meriden on the Hartford-Meriden Road; 23.2 per cent of the trucks

passing this station are of 5-ton capacity or larger. At station 35, on the same road, south of Hartford, 22.8 per cent of the trucks are of 5-ton capacity or larger.

The absence of 6 to 7½ ton trucks and a relatively low percentage of 5 to 5½ ton trucks at some survey stations marks the roads on which they are located as medium or light-trucking routes. At station 2, located west of Danbury on the Danbury-Brewster (New York) Road, there are no 6 to 7½ ton trucks and only 2.7 per cent of all the trucks have a capacity of more than 4 tons.

The relative importance of highways as heavy or light trucking routes is more clearly defined in terms of the average daily number of trucks of various capacities using them, also shown in Appendix VI. The importance of the number as well as the percentage of trucks of various capacities is indicated by the fact that, although the highest percentage of heavy trucks (5 to 7½ ton capacity) occurs at station 36, the average daily number of such trucks at this station is only 61 as compared with 165 at station 6, located west of Greenwich on the Boston Post Road. Of the 810 trucks passing station 6 daily, 455 are ½ to 1½ ton trucks, 111 are 2 to 2½ ton trucks, 79 are 3 to 4, 150 are 5 to 5½, and 15 are 6 to 7½ ton trucks.

It is possible from a study of the capacity of trucks using the highways of the State to classify certain routes, for purposes of highway design and surface type selection, as terminal highways and others as class A, B, and C highways. A terminal highway may be defined as a highway connecting large industrial centers, not widely separated and between which there is a daily motor truck traffic which consists of a large number of trucks of all capacities but especially of large-capacity trucks. Class A highways may be defined as carrying a smaller number of motor trucks of all capacities than terminal highways; class B highways as those the traffic of which consists mainly of small-capacity trucks; and class C highways as those over which the traffic of motor trucks of all capacities is relatively unimportant. In addition to the classification of highways, it is possible from a study of the movement of trucks of various capacities to establish certain general principles regarding the movement.

Highways classified on basis of truck traffic.—Figures 19 and 20 illustrate the movement of small and large-capacity trucks over the Connecticut highway system. The movement of ½ to 2½ ton trucks (fig. 19) is greatest in the southwestern section of the State, on the Boston Post Road. This road runs from New York, through Greenwich and Bridgeport, to New Haven, where it turns north through Meriden and Hartford; thence, following the

THE BOSTON POST ROAD AT DARIEN

east side of the Connecticut River, to Springfield, Mass., and then turns east to Worcester and Boston. Connecting, as it does, large centers of population and industrial areas, in and outside the State of Connecticut, the Boston Post Road carries a great volume of motor-truck traffic. Not only is the movement of ½ to 2½ ton trucks greatest on sections of this road, but the movement of large-capacity trucks (fig. 20) is also heavier on this route than on any other highway in the State. At Greenwich the average daily number of 5 to 7½ ton trucks is 165, and at no point between Greenwich and the Massachusetts line is the average number of trucks of this largest size less than 40 per day. From the standpoint of the movement of large-capacity trucks, the Boston Post Road is therefore the most important route in the State. For the purposes of selection of highway type and design and to establish its relative importance as compared with other highways in the State, it may be classified as a terminal highway; and

THE BOSTON POST ROAD IS CLASSIFIED AS A TERMINAL HIGHWAY. BECAUSE OF THE IMPORTANCE OF ITS TRAFFIC, IT IS ENTITLED TO THE HIGHEST TYPE OF PAVEMENT OF THE HEAVIEST DESIGN. THIS VIEW SHOWS A STONE FOUNDATION LAID AS A PART OF THE RECONSTRUCTED HIGHWAY NEAR GREENWICH

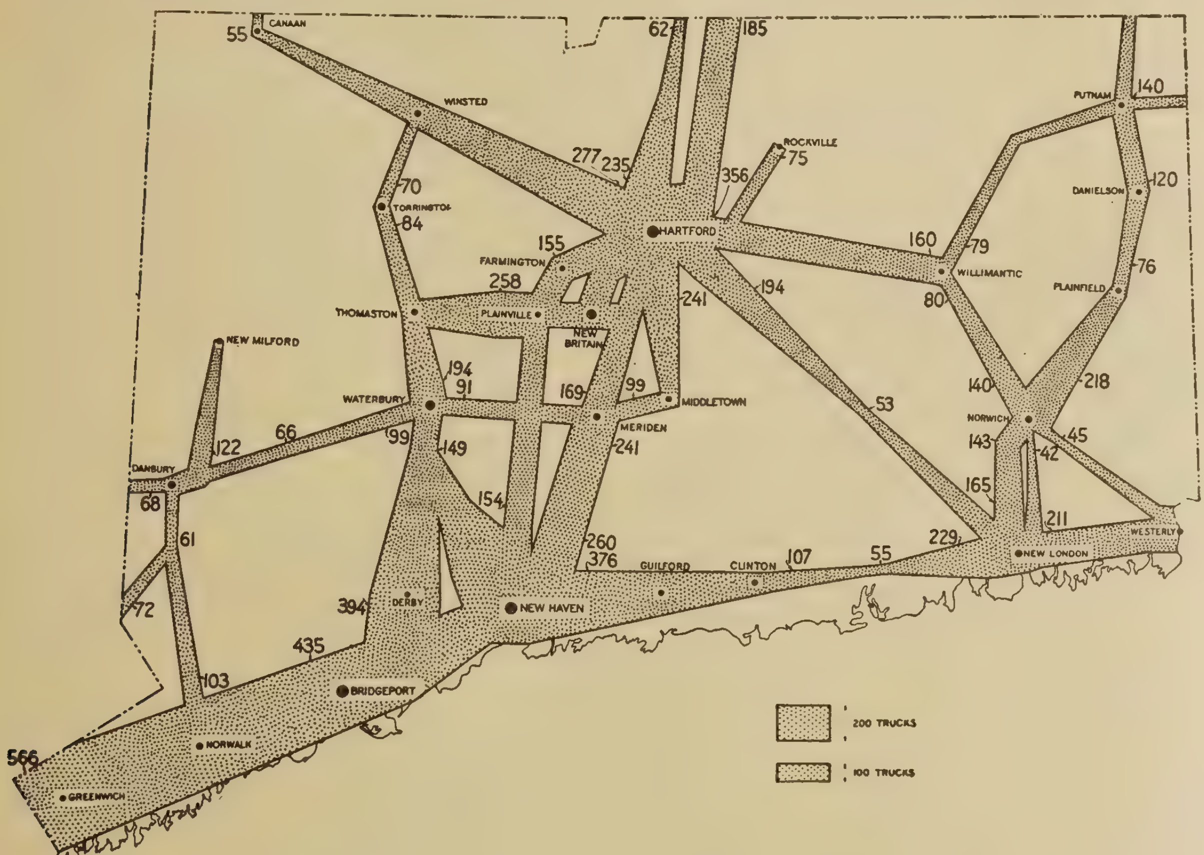


FIG. 19.—AVERAGE DAILY TRAFFIC OF SMALL-CAPACITY TRUCKS (½ TO 2½ TONS) ON THE IMPORTANT HIGHWAYS OF CONNECTICUT

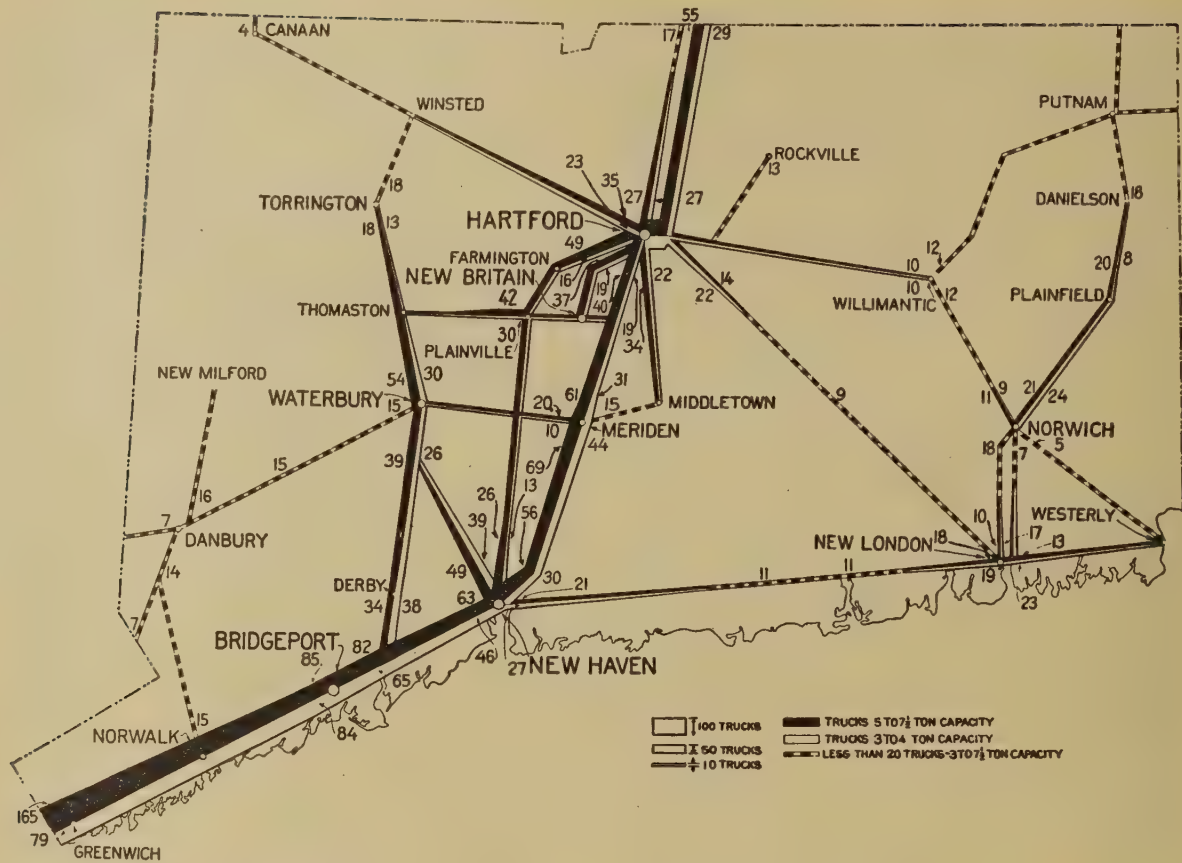


FIG. 20.—AVERAGE DAILY TRAFFIC OF LARGE-CAPACITY MOTOR TRUCKS (3 TO 7½ TONS) ON THE IMPORTANT HIGHWAYS OF CONNECTICUT

A SECTION OF THE BRIDGEPORT-WATERBURY-THOMASTON ROUTE IN THE TOWN OF SEYMOUR. THIS ROAD WHICH IS SURFACED WITH TOPEKA MIX BITUMINOUS CONCRETE IS CLASSIFIED AS A CLASS A HIGHWAY

it is also the most important route for all motor vehicles. It is therefore entitled to the highest type of pavement of the heaviest design.

Highways which can be classified as class A routes are the Bridgeport-Waterbury-Thomaston Road, the New Haven-Waterbury Road, the Hartford-Plainville, and Hartford-New Britain Roads. The movements of both large and small-capacity trucks are heavy on these routes. On the Bridgeport-Waterbury-Thomaston Road the average number of 5 to 7½ ton trucks ranges from 34 to 54 per day; 3 to 4 ton trucks average between 26 and 38 per day on different sections of it; and ½ to 2½ ton trucks average 394 per day between Bridgeport and Derby, 149 per day south of Waterbury, and 194 per day north of Waterbury.

The New Haven-Waterbury Road, which joins the Bridgeport-Waterbury Road, south of Waterbury, is another class A route. The traffic decreases on this route as it approaches the intersection south of Waterbury but it is heavy on the New Haven section of the road. An average of 39 trucks of 3 to 4 ton capacity and 49 of 5 to 7½ ton capacity pass daily over that section of the route near New Haven.

On the other class A highways, the Hartford-Plainville, and the Hartford-New Britain Roads, large-capacity trucks average 65 and 56 per day, respectively.

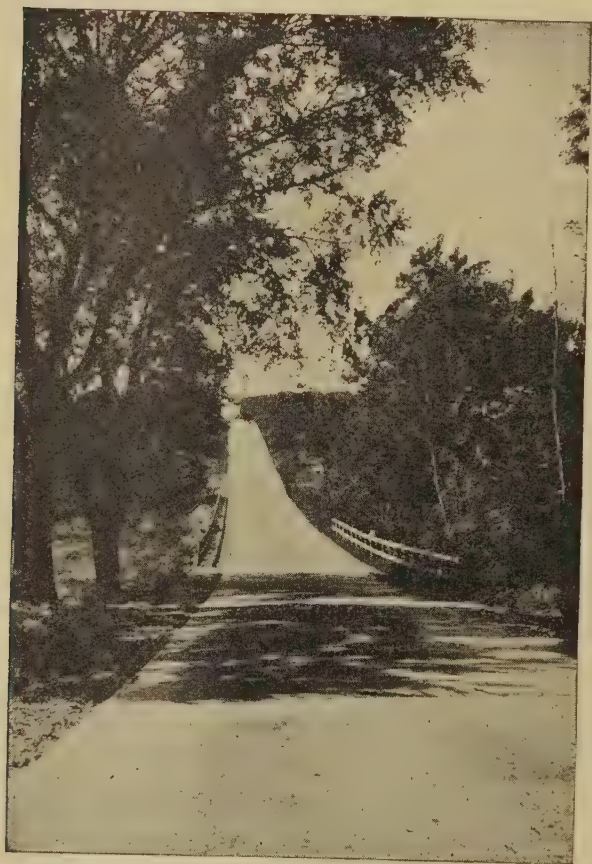
Class B routes are the Thomaston-Torrington, the New Haven-Plainville, Waterbury-Meriden, and Thomaston-Plainville Roads, and the routes leading out of Hartford to Winsted, Middletown, Willimantic, and Springfield (on the west side of the Connecticut River). The New Haven-Westerly and New London-Putnam Roads can also be classified as class B routes.

A Concrete Section of the Boston Post Road Which Replaces an Old Waterbound Macadam Section. In the New Construction, the Bank at the Right Has Been Cut Back to Extend the Sight Line

The remaining roads of the State highway system are classified as class C highways. These include, in the western section of the State, the roads out of Danbury and the roads from Winsted to Canaan and Winsted to Torrington. In the eastern section the class C routes are the Hartford-New London Road; the road south from Rockville; the Middletown-Meriden Road; the roads out of Putnam to the north and east, and southwest to Willimantic; and the roads out of Norwich to Willimantic and Westerly. The average daily number of trucks of over 2½ ton capacity (fig. 20) is below 20 on the majority of these routes which are classified as class C highways. These roads are confined to definite areas, surrounding Danbury and Winsted in the western section of the State and surrounding Putnam, Rockville, Willimantic, the areas lying southeast and northwest of Norwich, and the area between Hartford and New London in the eastern part of the State. These areas and the highways in them, because of the small amount of heavy trucking and the relatively small amount of light trucking can be regarded, from the standpoint of motor trucking, as least important in a highway improvement program.

Several significant features are observable in the movement of trucks of the various capacities over the Connecticut highway system. One of these is the great volume of ½ to 2½ ton trucks (fig. 19) observed around large centers of population and between adjacent large centers of population. This condition is apparent around Hartford, New Haven, and Bridgeport and is accounted for, in large part,

by the fact that large cities and towns are distribution centers for commodities and because, in this distribution of commodities, the small-capacity truck is in general the most economical unit. The movement of small-capacity trucks is predominantly a local or short-haul movement. This is particularly true of the ½ to 1½ ton trucks, the average trip mileage of which ranges from 12 to 18 miles (Table 18). Of all ½ to 2½ ton trucks recorded in Connecticut, 55.6 per cent traveled less than 10 miles per trip and 76.9 per cent traveled less than 20 miles per trip. One-half ton trucks, which constitute 31.6 per cent of the ½ to 2½ ton groups, average 12 miles per trip (Table 18); and it is also to be noted that 64.7 per cent (Table 19) of the ½-ton trucks travel less than 10 miles per trip and 84.2 per cent less than 20 miles per trip. It is evident, therefore, that the movement of small-capacity trucks is not a long-haul movement but a local or short-haul movement influenced by centers of population (fig. 21).



THE HARTFORD-NEW LONDON ROAD, A CLASS C HIGHWAY

Table 18.—Average trip mileage of motor trucks of various capacities

Capacity (tons)	Average trip (miles)	Capacity (tons)	Average trip (miles)
½	12	4	30
¾	17	5	45
1	15	5½	54
1¼	18	6	36
1½	17	6½	42
2	27	7½	60
2½	34		
3	29	All capacities	22
3½	33		

An analysis of the trip mileage of small trucks recorded at survey stations surrounding New Haven indicates that 67.3 per cent of these trucks (of ½ to 2½ ton capacity) travel less than 10 miles per trip, and that 82.6 per cent of them travel less than 20 miles per trip. A similar analysis of the movement of ½ to 2½ ton trucks around Hartford shows that 59.2 per cent travel less than 10 miles per trip and 86.4 per cent of them travel less than 20 miles.

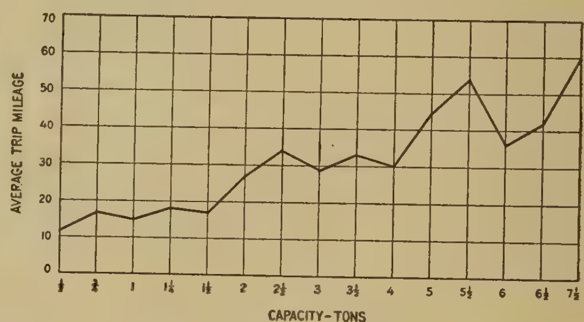


FIG. 21.—AVERAGE TRIP MILEAGE OF MOTOR TRUCKS OF VARIOUS CAPACITIES

It can therefore be stated as a general principle that the movement of trucks of ½ to 2½ ton capacity is greatest around centers of population, and that it is predominantly a local and short-haul movement. The problem of providing highway service for these trucks is mainly one of providing for light, pneumatic-tired vehicles. Of the total number of ½ to 2½ ton trucks observed, 67.4 per cent were equipped with pneumatic tires on all wheels and an additional 6.2 per cent were equipped with pneumatic tires on either front or rear wheels.

Table 19.—Distribution of motor trucks of various capacities by lengths of trip

Length of trip in miles	Capacity (tons)							
	½		¾		1		1¼	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0–9	13, 422	64. 7	1, 609	51. 2	9, 220	60. 5	4, 989	48. 1
10–19	4, 050	19. 5	678	21. 6	3, 210	21. 1	2, 465	23. 7
20–29	1, 393	6. 7	373	11. 9	1, 243	8. 2	1, 156	11. 1
30–39	815	3. 9	220	7. 0	563	3. 7	682	6. 6
40–49	318	1. 5	75	2. 4	260	1. 7	349	3. 4
50–59	247	1. 2	78	2. 5	212	1. 4	271	2. 6
60–69	121	. 6	24	. 7	99	. 7	131	1. 3
70–79	108	. 5	29	. 9	105	. 7	85	. 8
80–89	39	. 2	7	. 2	37	. 2	42	. 4
90–99	42	. 2	10	. 3	31	. 2	33	. 3
100 and over	196	1. 0	40	1. 3	248	1. 6	178	1. 7
Total	20, 751	100. 0	3, 143	100. 0	15, 228	100. 0	10, 381	100. 0

Length of trip in miles	Capacity (tons)—Continued							
	1½		2		2½		3	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0–9	2, 538	51. 4	3, 400	42. 3	1, 290	41. 5	602	43. 2
10–19	1, 126	22. 8	1, 792	22. 3	673	21. 6	279	20. 0
20–29	524	10. 6	894	11. 1	366	11. 8	149	10. 7
30–39	262	5. 2	645	8. 0	225	7. 3	123	8. 8
40–49	124	2. 5	290	3. 6	87	2. 8	52	3. 7
50–59	124	2. 5	230	2. 9	86	2. 8	66	4. 8
60–69	55	1. 1	102	1. 3	50	1. 6	10	. 7
70–79	46	1. 0	129	1. 6	72	2. 3	20	1. 4
80–89	20	. 4	54	. 7	29	. 9	12	. 9
90–99	25	. 5	65	. 8	23	. 7	15	1. 1
100 and over	97	2. 0	429	5. 4	209	6. 7	65	4. 7
Total	4, 941	100. 0	8, 030	100. 0	3, 110	100. 0	1. 393	100. 0

Length of trip in miles	Capacity (tons)—Continued							
	3½		4		5		5½	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0–9	2, 081	37. 5	214	39. 6	2, 447	29. 1	96	25. 1
10–19	1, 098	19. 8	109	20. 2	1, 384	16. 5	56	14. 6
20–29	714	12. 9	81	15. 0	880	10. 5	35	9. 1
30–39	470	8. 5	50	9. 2	978	11. 6	55	14. 4
40–49	175	3. 2	11	2. 0	400	4. 8	15	3. 9
50–59	213	3. 8	11	2. 0	465	5. 5	26	6. 8
60–69	113	2. 0	8	1. 5	282	3. 4	12	3. 1
70–79	144	2. 6	7	1. 3	319	3. 8	13	3. 4
80–89	49	. 9	1	. 2	99	1. 2	3	. 8
90–99	37	. 7	4	. 7	92	1. 1	2	. 5
100 and over	450	8. 1	45	8. 3	1, 052	12. 5	70	18. 3
Total	5, 544	100. 0	541	100. 0	8, 398	100. 0	383	100. 0

Table 19.—Distribution of motor trucks of various capacities by lengths of trip—Continued

Length of trip in miles	Capacity (tons)—Continued							
	6		6½		7½		Total	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
0–9	69	25. 1	119	26. 0	25	15. 3	42, 121	50. 9
10–19	43	15. 6	59	12. 9	2	1. 2	17, 024	20. 6
20–29	41	14. 9	74	16. 2	16	9. 8	7, 939	9. 6
30–39	35	12. 7	64	14. 0	11	6. 8	5, 198	6. 3
40–49	11	4. 0	24	5. 2	10	6. 1	2, 201	2. 7
50–59	11	4. 0	26	5. 7	27	16. 6	2, 093	2. 5
60–69	4	1. 5	9	2. 0	14	8. 6	1, 034	1. 2
70–79	16	5. 8	30	6. 6	16	9. 8	1, 139	1. 4
80–89	3	1. 1	3	. 7	12	7. 4	410	. 5
90–99	2	. 7	6	1. 3	2	1. 2	389	. 4
100 and over	40	14. 6	43	9. 4	28	17. 2	3, 190	3. 9
Total	275	100. 0	457	100. 0	163	100. 0	82, 738	100. 0

The movement of large-capacity trucks, especially the 5 to 7½ ton trucks, in Connecticut (fig. 20) is not confined to areas surrounding the large centers of population. A considerable part of this movement on the main highways can be classed as a "through" movement connecting large manufacturing centers, both in and outside the State. The predominating capacity in the 5 to 7½ ton group is the 5-ton capacity, which constitutes 86.8 per cent of all trucks in the group. Of the 5-ton trucks passing survey station 6, on the Boston Post Road at Greenwich, it was found that 44.4 per cent were transporting commodities between New York (and points west) and Bridgeport (and points east). The distance between Bridgeport and New York is 58 miles, so that the minimum trip mileage of 44.4 per cent of the 5-ton trucks passing station 6, at Greenwich, is 58 miles; and for those trucks that traveled through Bridgeport to New Haven, Hartford, Springfield, or Boston, of which there were many, the trip mileage was considerably over 58 miles.

The location of the State of Connecticut is a contributory factor to the long-haul movement of large-capacity trucks. Connecticut is a highly developed industrial area and its highways are the main traffic arteries between New York City and New England points. The location of the State, at the gateway to New England, results in a larger proportion of long-distance haulage by large-capacity vehicles.

But, although a large percentage of the 5-ton trucks on main through highways of the State are engaged in a long-haul movement of commodities, it is not true for the State as a whole. Only 27.5 per cent of the 5-ton trucks travel more than 50 miles per trip (Table 19), while 29.1 per cent travel less than 10 miles per trip and 45.6 per cent less than 20 miles per trip. It can be stated that on main, through highways, such as the Boston Post Road, a large percentage of 5-ton trucks are engaged in long-haul transportation but that on the less important and branch highways the 5-ton movement is a short-haul movement. Evidence of this short-haul movement is shown by an analysis of the 5-ton truck movement over the New Haven-Waterbury Road on which 81.9 per cent of the 5-ton trucks travel less than 10 miles and 88.6 per cent less than 20 miles per trip.

A comparison of the capacities of motor trucks operating between certain points of origin and destination separated by various distances indicates the predominant size of motor trucks used in short and long-haul transportation.

It is evident from Table 20 that there is a definite relation in Connecticut between motor-

truck capacity and the length of haul. The percentage of ½ to 2½ ton trucks decreases from 68.1 per cent in the 18-mile haul to 22.6 in the 142-mile haul; the percentage of 5 to 7½ ton trucks increases from 16.2 in the 18-mile haul to 61.2 in the 142-mile haul. The points of origin and destination in Table 20 are on the Boston Post Road, the main artery of traffic between New York and Boston and intermediate points.

Table 20.—Capacities of motor trucks operating between certain points of origin and destination

Capacity groups (tons)	Bridgeport and New Haven, 18 miles		New York and Bridgeport, 58 miles		New York and Hartford, 115 miles		New York and Springfield, 142 miles	
	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent
½–2½	618	68. 1	158	41. 5	72	26. 9	32	22. 6
3–4	143	15. 7	77	20. 2	33	12. 3	23	16. 2
5–7½	147	16. 2	146	38. 3	163	60. 8	87	61. 2
Total	908	100. 0	381	100. 0	268	100. 0	142	100. 0

MOTOR TRUCK LOADING PRACTICES

APPROXIMATELY two-thirds of all motor trucks observed on the Connecticut highways during the course of the survey were loaded.

Comparing the large and small-capacity trucks, it was found that a somewhat larger proportion of the former was loaded. Of the total number of ½-ton trucks, for instance, 60.5 per cent were found to be loaded; while the loaded 5-ton trucks were 66.3 per cent of the total number. Although the differences between the proportion of loaded small-capacity and large-capacity trucks are not very great, it is apparent that the large-capacity trucks more frequently get return loads.

The predominating gross loads of trucks of the several capacities are shown in Table 21. Of the total number of ½ to 1½ ton loaded trucks, this table shows that 65.2 per cent have gross weights under 5,000 pounds. Approximately one-half (50.9 per cent) of the 2 to 2½ ton loaded trucks have gross weights between 10,000 and 15,000 pounds. About one-half of the 5 to 5½ and 6 to 7½ ton loaded trucks have gross weights between 20,000 and 25,000 pounds. The distribution of all loaded trucks by gross weight groups is also shown in this table and in Figure 22.

The general tendencies in motor-truck loading are shown by the average net and gross weights for trucks of each capacity as recorded in Table 22.

It will be noted that the average gross weight of 1-ton trucks is less than the average gross weight of ¾-ton trucks. This difference is due to the fact that a majority of the 1-ton trucks are Fords which have a lighter empty weight than 1-ton trucks of other makes. The high average net and gross weights for 6-ton trucks are due to the small number of samples upon which these averages are based. The comparatively low average net weight for the 7½-ton capacity is due to the tendency of operators to avoid loading trucks of this large size to the capacity limit for fear of exceeding the legal maximum gross weight limit of 25,000 pounds. The 7½-ton truck empty weighs between 13,000 and 14,000 pounds, and can only transport a maximum net load between 11,000 and 12,000 pounds (rather than its rated maximum of 15,000 pounds) because of the 25,000-pound gross-weight limitation.

There is a tendency to load the 2, 2½, 3½, 5, and 6 ton trucks nearer the limit of their rated capacities. Trucks of these capacities can therefore be expected to be the principal motor trucks carrying loads in excess of rated capacity, since the ratio of their average net load to their capacity is higher than in the case of the other capacities.

Table 21.—Distribution of loaded motor trucks by capacity and gross weight

Gross weight, in pounds	Capacity groups (tons) ½–1½		2–2½		3–4		5–5½		6–7½		All capacities	
	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent
Under 5,000	10, 912	65. 2	31	0. 5							10, 943	31. 4
5,000–9,999	5, 590	33. 4	2, 750	43. 7	155	3. 9					8, 495	24. 4
10,000–14,999	234	1. 4	3, 204	50. 9	1, 656	41. 5	920	12. 9	24	3. 6	6, 038	17. 3
15,000–19,999			290	4. 6	1, 708	42. 8	2, 133	29. 9	134	20. 2	4, 265	12. 3
20,000–24,999			19	. 3	447	11. 2	3, 438	48. 2	353	53. 2	4, 257	12. 2
25,000 and over					24	0. 6	642	9. 0	153	23. 0	819	2. 4
Total	16, 736	100. 0	6, 294	100. 0	3, 990	100. 0	7, 133	100. 0	664	100. 0	34, 817	100. 0

The average net weight per loaded motor truck passing the survey stations varied from 1,890 pounds at station 5, to 4,110 pounds at station 36, and the average gross weight from 5,720 pounds at station 5, to 10,580 pounds at station 35. The average gross weight of empty motor trucks varied from 3,490 pounds at station 5 to 6,440 pounds at station 36.

MOTOR-TRUCK OVERLOADING

Almost one-third of the loaded motor trucks observed on the Connecticut highways during the survey carried net loads in excess of their rated capacities. The extent of this overloading is shown in Table 23. Of the total number of loaded trucks, 30.2 per cent were loaded over their rated capacity and 2.1 per cent had gross weights in excess of 25,000 pounds. Of all sizes of trucks, those of 2, 2½, 3½, and 5-ton capacity were found most frequently to be loaded beyond their rated capacity. The percentages of trucks of these sizes so overloaded were 38.1, 41.8, 38.1, and 41.1 per cent respectively. Proportionately heavier loading and overloading of large-capacity trucks are apparent (fig. 23).

The fact that 2.1 per cent of the total gross loads exceed the 25,000-pound legal limit is significant. No gross loads over 25,000 pounds were found on trucks of 3 tons capacity or smaller. It would be almost impossible for trucks of these smaller sizes to carry a 25,000-pound gross load. For this reason it would probably be more accurate to compute the percentage of loads in excess of the gross-weight limit on the basis of the number of loaded 3½ to 7½ ton trucks. Applying this method it is found that of the total number of 3½ to 7½ ton loaded trucks recorded, 6.4 per cent were loaded in excess of 25,000 pounds gross.

Table 22.—Average net and gross weight of trucks of the several capacities

Capacity (tons)	Number of trucks	Average net weight (pounds)	Average gross weight (pounds)
½	5, 072	720	2, 950
¾	1, 375	1, 090	5, 210
1	5, 167	1, 440	4, 370
1¼	3, 443	1, 560	5, 270
1½	1, 679	2, 310	7, 350
2	4, 435	3, 570	10, 040
2½	1, 859	4, 660	11, 580
3	335	4, 430	12, 770
3½	3, 507	6, 020	15, 820
4	148	6, 690	16, 820
5	6, 897	8, 680	20, 170
5½	236	8, 440	20, 380
6	16	10, 900	22, 200
6½	430	10, 180	22, 590
7½	218	9, 520	22, 200

On the terminal and class A highways overloaded trucks are more frequent. The highest percentage of trucks loaded beyond their rated capacity was observed at station 11, on the Boston Post Road at West Haven, where 35 per cent of the loaded trucks recorded were thus overloaded. With the exception of station 4 at Danbury and station 30 at Putnam, the

capacity overloads exceeded 25 per cent of the total number of loaded trucks at all weight stations. Overloading beyond the legal maximum gross weight limit of 25,000 pounds was most frequent at station 6, on the Boston Post Road at Greenwich. At that station 2.6 per cent of the total number of loaded trucks and 7.3 per cent of the 3½ to 7½ ton trucks had gross weights exceeding the legal limit. At all weight stations on this important road (stations 6, 11, and 46) between 2.2 and 2.6 per cent of all loaded trucks and from 5.7 to 7.7 per cent of the 3½ to 7½ ton trucks were loaded beyond the gross weight limit.

At station 56, located at Naugatuck on the Bridgeport-Waterbury Road which has been classified as a class A route, 2.3 per cent of the total number of loaded trucks recorded and 6.2 per cent of the 3½ to 7½ ton loaded trucks were loaded beyond the legal gross weight limit; and station 40, also on a class A route, shows also a comparatively high percentage of

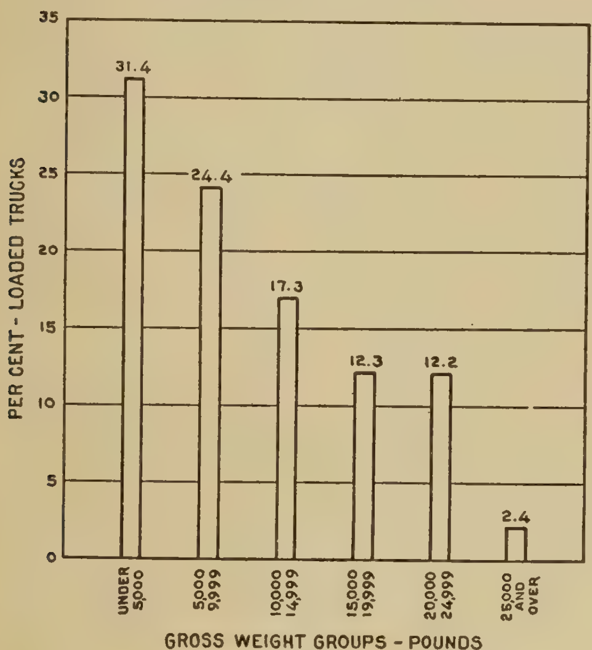


Fig. 22.—Distribution of Loaded Motor Trucks by Gross Weight Groups

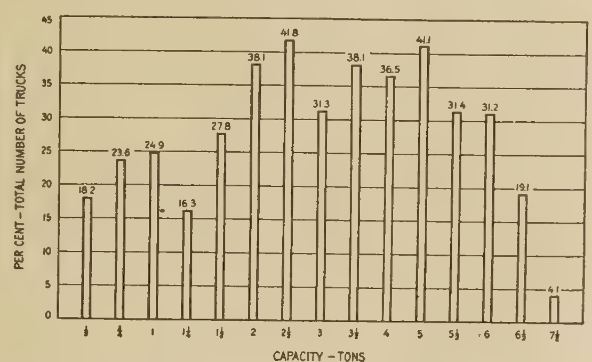


Fig. 23.—Percentage of Total Number of Loaded Trucks of Each Capacity Carrying Net Loads Over Rated Capacity

Table 23.—Extent of motor truck overloading on Connecticut highway system

Truck capacity (tons)	Trucks not loaded over rated capacity		Trucks loaded over rated capacity		Total number of loaded trucks	Gross loads over 25,000 pounds	
	Number	Percentage of total number	Number	Percentage of total number		Number	Percentage of total number
½	4, 150	81. 8	922	18. 2	5, 072		
¾	1, 051	76. 4	324	23. 6	1, 375		
1	3, 883	75. 1	1, 284	24. 9	5, 167		
1¼	2, 881	83. 7	562	16. 3	3, 443		
1½	1, 212	72. 2	467	27. 8	1, 679		
2	2, 745	61. 9	1, 690	38. 1	4, 435		
2½	1, 082	58. 2	777	41. 8	1, 859		
3	230	68. 7	105	31. 3	335		
3½	2, 171	61. 9	1, 336	38. 1	3, 507	19	0. 5
4	94	63. 5	54	36. 5	148	1	. 7
5	4, 065	58. 9	2, 832	41. 1	6, 897	558	8. 1
5½	162	68. 6	74	31. 4	236	20	8. 5
6	11	68. 8	5	31. 2	16	3	18. 8
6½	348	80. 9	82	19. 1	430	101	23. 5
7½	209	95. 9	9	4. 1	218	35	16. 1
Total	24, 294	69. 8	10, 523	30. 2	34, 817	737	2. 1

gross weight overloads. On the other hand, stations 4, 28, and 30, located on either class B or C routes have a relatively small percentage of loads in excess of 25,000 pounds gross weight.

The distribution of capacity overloads according to the amount of excess load is shown in Appendix VII. The maximum net load permitted on a ½-ton truck is 1,000 pounds. The excess over 1,000 pounds on ½-ton trucks is termed "amount of excess load" in Appendix VII, and the amount of excess for other truck sizes is similarly determined. Of the total number of ½-ton capacity overloads, 83 per cent have an excess load under 1,000 pounds and the remaining 17 per cent transport net loads which are 1,000 pounds or more in excess of the rated capacity. It should be noted that the ½-ton trucks with an excess load of 1,000 pounds are transporting twice the rated capacity of these trucks. Yet the appendix table shows that 17 per cent of all the trucks of this size were overloaded to that extent or greater, and a few carried excess loads of over 4,000 pounds. Although these extreme cases are exceptional, they are certainly unreasonable and inexcusable in any case.

The tendency for the amount of excess load to increase as the rated capacity increases is also shown in Appendix VII. The percentage of excess loads between 1 and 999 pounds, the lowest group, is 83 per cent for ½-ton trucks, 70.2 per cent for 1-ton trucks, 33.7 per cent for 2-ton trucks, 25 per cent for 3½-ton trucks, and 23.6 per cent for 5-ton trucks.

On the other hand, the percentage of the heavier overloads was considerably greater in the case of the larger trucks. For example, an analysis of the 5-ton capacity overloads shows that 15.2 per cent are 2 tons or more and 5.3 per cent 3 tons or more. These loads can not be regarded as exceptional, and similar cases of extremely large excess loads are noted for trucks of other capacities. They represent, in general, unreasonably heavy loading on undertired vehicles which are neither constructed nor mechanically equipped to carry these loads.

The gross weight overloads are classified according to the amount of excess load in Appendix VIII, which shows that the largest amount of loading over 25,000 pounds gross weight occurs on 5-ton trucks. More than one-half (56.6 per cent) of the 5-ton gross weight overloads represent an excess load of 1,000 pounds or more; and 6.7 per cent of these overloaded trucks have an excess load of 5,000 or more pounds, which indicates a total gross load over 30,000 pounds for these trucks.

REAR-AXLE LOADING

Appendix IX shows the percentage of total gross weight on the rear axle of trucks with net loads less than 50 per cent of the capacity rating, from 50 to 100 per cent of capacity rating, and over 100 per cent. Two general tendencies are apparent. First, the proportion of total gross weight on the rear axle is greater for trucks with the heavier net loads. The ½-ton trucks which have net loads of less than 50 per cent capacity, from 50 to 100 per cent, and over 100 per cent of capacity have, respectively, 56.3 per cent, 61.9 per cent, and 63.8 per cent, of the total gross weight on the rear axle, and similar increases in percentage on the rear axle with increase in net load are found in the case of the other truck capacities.

The second general tendency in rear-axle loading is to put a higher percentage of the total gross weight on the rear axle of the trucks of larger capacity. The one exception to this practice is found in the case of the 1-ton trucks which have a higher percentage on the rear axle than some of the larger capacities. This is due primarily to the fact that the majority of 1-ton trucks are light-weight trucks, such as Fords.

The maximum loads listed in Appendix IX include only those loads which can reasonably be expected to recur and do not include extremely rare and infrequent loads.

TYPE OF TIRE EQUIPMENT

Pneumatic tires are used on 99 per cent of the ½-ton trucks (Table 24). They also form the chief tire equipment for the ¾, 1, 1¼, and 1½ ton trucks. The trucks of larger capacity are mainly equipped with solid tires on both front and rear wheels, although there is some usage of combinations of the two tire types, using the solid type on the rear wheels and the pneumatic type on the front wheels.

The average net and gross loads of trucks vary considerably for trucks of the same capac-

Table 24.—Types of tires used on trucks of the several capacities

Truck capacity (tons)	Total number of trucks	Pneumatic tires		Solid tires		Combination of solid and pneumatic tires	
		Number of trucks	Per cent	Number of trucks	Per cent	Number of trucks	Per cent
½	3, 608	3, 571	99. 0	14	0. 4	23	0. 6
¾	1, 000	969	96. 9	23	2. 3	8	. 8
1	3, 783	3, 334	88. 1	215	5. 7	234	6. 2
1¼	2, 442	2, 381	97. 5	48	2. 0	13	. 5
1½	1, 362	762	55. 9	502	36. 9	98	7. 2
2	4, 004	951	23. 8	2, 520	62. 9	533	13. 3
2½	1, 744	128	7. 4	1, 420	81. 4	196	11. 2
3	314	47	15. 0	226	72. 0	41	13. 0
3½	3, 408	136	4. 0	3, 020	88. 6	252	7. 4
4	141	1	. 7	120	85. 1	20	14. 2
5	6, 747	53	. 8	6, 328	93. 8	366	5. 4
5½	234	2	. 9	228	97. 4	4	1. 7
6	16	0	----------	15	93. 7	1	6. 3
6½	425	6	1. 4	404	95. 1	15	3. 5
7½	218	3	1. 4	208	95. 4	7	3. 2

ity according to the type of tire equipment (Appendix X). Trucks equipped with pneumatic tires on both front and rear wheels are, in general, less heavily loaded than those which are equipped either with solid tires only or with a combination of pneumatic and solid tires. The heaviest loading occurs on the trucks that have solid tires on all four wheels.

Analyzing the trip mileage of the trucks with respect to the tire equipment, it appears that the majority of pneumatic-tired trucks—84.5 per cent—travel less than 40 miles. Of the solid-tired trucks, 58.8 per cent travel less than 40 miles; and of all trucks with the three types of tire equipment, 3.5 per cent of the pneumatic-tired, 12.9 per cent of the solid-tired, and 24 per cent of those equipped with a combination of solid and pneumatic tires, travel 100 miles or more at a trip.

LOAD PER INCH WIDTH OF REAR TIRE

In addition to prohibiting gross weights in excess of 25,000 pounds, the statutes of Connecticut also provide that the weight of trucks equipped with solid tires shall not exceed 800 pounds per inch width of tire, channel measurement, and that no commercial vehicle shall be so loaded that the weight on one axle is less than 20 per cent of the gross weight of vehicle and load.

To determine the prevalence of violations of this statute an analysis was made of the weights per inch width of tire on 4,580 loaded trucks equipped with solid tires. This analysis indicated that loads in excess of 800 pounds per inch, channel measurement, were very exceptional on the front axle and the data here presented are therefore limited to rear axle loads. Of the 4,580 loaded trucks analyzed 102, or 2.2 per cent, were found to have weights per inch width of rear tire, channel measurement, in excess of 800 pounds.

Examining the extent to which the overloading indicated by violation of this statute is confirmed by the other determinants of overloading, that is, loading in excess of rated capacity and loading in excess of 25,000 pounds gross weight, it is found that of the 4,580 trucks referred to above 2,810 or 61.4 per cent were loaded to less than their rated capacity and of these only 20, or 0.7 per cent, were loaded in excess of 800 pounds per inch width of tire, channel measurement. Of the 1,770 trucks, 38.6 per cent of the total number, that were loaded in excess of rated capacity, 82 or 4.6 per cent, were loaded in excess of 800 pounds per inch width of tire, channel measurement; and of the 144 trucks the gross weight of which exceeded 25,000 pounds, 27 or 18.8 per cent, violated the tire-weight statute.

These relations of the three determinants are shown in Table 25, in which the 4,580 trucks are distributed according to the weight per inch width of tire, as determined by the channel measurement and the contact measurement, respectively.

The Connecticut statute specifies that the tire measurement shall be made between the flanges of the channels. Many of the States employ the same basis; others measure the tire width in contact with the road surface. Whichever of the two methods is specified it is the load per inch width of tire in contact with the road surface that actualy determines the effect of the load upon the road. In order, therefore, to determine the relation between the indications of the two methods the test trucks were measured in both ways and the unit weights based on both measurements are tabulated in Table 25. It will be noted that there are small differences in the total numbers of trucks for which the two measurements are reported. This difference is due to the omission of the contact measurement upon a few trucks; but with these few exceptions the trucks included in each group are identical.

The larger number of loads in excess of 800 pounds per inch of tire width in contact with the highway surface is apparent. For less-than-capacity loads the percentage over 800 pounds increases from 0.7 per cent, channel measure, to 9.8 per cent, contact measure. For loads in excess of rated capacity the percentage over 800 pounds per inch increases from 4.6 per cent, channel measure, to 39 per cent, contact measure, and the corresponding increase for loads in excess of 25,000 pounds gross weight is from 18.8 per cent, channel measure, to 75.3 per cent, contact measure.

The variations in the distribution according to the two methods are more clearly indicated by Figures 24, 25, and 26. The two distributions are very similar in general outline but in each case the contact-measurement weight is over 100 pounds higher. These variations are apparent from a comparison of the medians of each distribution shown in Table 26.

It will be noted from Table 26 that the weight per inch of tire width, contact measurement, is from 132 to 173 pounds greater than the channel-measurement weight, and that the contact-measurement weights are from 23 to 29 per cent higher than the corresponding channel-measurement weights, indicating that a limitation of loads to 800 pounds per inch of tire, channel measurement, is approximately

Measuring the Width of Truck Tires to Determine the Weight Per Inch of Width

Table 25.—Distribution of loads per inch width of tire, channel and contact measurement, in relation to other determinants of overloading

Rear wheel weight per inch of tire width (pounds)	Number of less-than-capacity loads		Number of loads in excess of rated capacity		Number of loads in excess of 25,000 pounds gross weight	
	Channel measurement	Contact measurement	Channel measurement	Contact measurement	Channel measurement	Contact measurement
100	5	2	------	------	------	------
200	70	15	3	1	------	------
300	498	112	20	6	------	------
400	772	407	104	18	------	1
500	693	618	317	73	3	1
600	459	586	480	205	4	1
700	231	428	563	304	64	2
800	62	355	201	448	46	30
900	17	169	64	337	20	48
1,000	3	77	14	217	6	41
1,100	------	17	2	96	------	10
1,200	------	8	2	16	1	4
1,300	------	------	------	7	------	2
1,400	------	2	------	1	------	2
1,500	------	------	------	------	------	------
1,600	------	------	------	------	------	------
Over 1,600	------	1	------	1	------	------
Total	2,810	2,797	1,770	1,730	144	142

equivalent to a limit of 1,000 pounds per inch of tire measure at the point of tire contact with the highway surface.

The Connecticut statutes provide the following minimum tire thickness for solid truck tires:

Tire width, channel measurement	Tire thickness, in inches
5 inches or less	⅞
6 to 8 inches	1
Over 8 inches	1⅛

The thickness of tires on the trucks of which the weights per inch of tire were analyzed are shown in Tables A, B, and C of Appendix XI.

From these tables it is evident that very few trucks, less than 0.5 per cent of the total, are operating on tires less than 1 inch in thickness, and that the number operating on tires less than 1.5 inches in thickness varies from 2.8 per cent of the loads in excess of 25,000 pounds gross weight to 8.5 per cent of the less-than-capacity loads. Over 60 per cent of all trucks operate on tires between 1.5 and 2.4 inches in thickness.

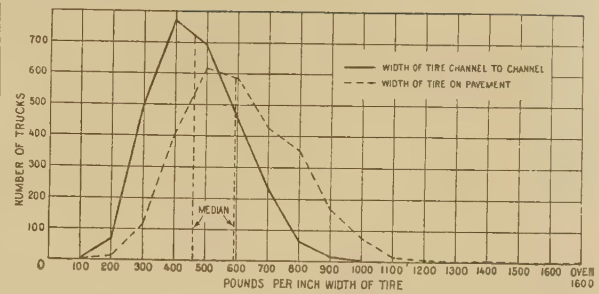


Fig. 24.—Analysis of Motor Trucks Carrying Less-than-Capacity Loads With Respect to Their Weight Per Inch Width of Tire as Determined by Channel and Contact Measurements, Respectively

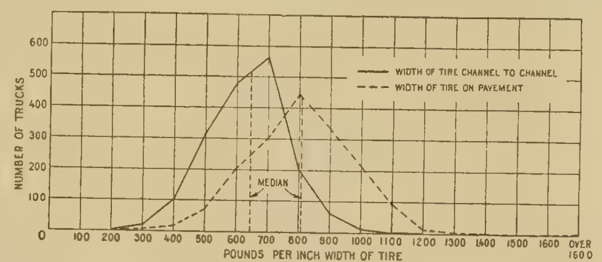


Fig. 25.—Analysis of Motor Trucks Carrying Loads in Excess of Rated Capacity With Respect to Their Weight Per Inch Width of Tire as Determined by Channel and Contact Measurements, Respectively

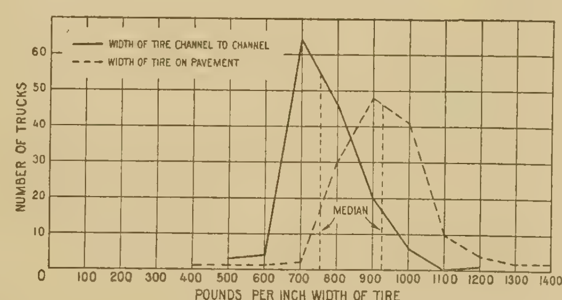


Fig. 26.—Analysis of Motor Trucks of Gross Load in Excess of 25,000 Pounds With Respect to Their Weight Per Inch Width of Tire as Determined by Channel and Contact Measurements, Respectively

Table 26.—Median weight per inch of rear tire width by channel and contact measurements

Load	Median weight per inch of tire width		Ratio of contact to channel measurement weight
	Channel measurement	Contact measurement	
	Pounds	*Pounds*	*Per cent*
Less-than-capacity loads	460	592	129
Loads in excess of rated capacity	642	808	126
Gross loads over 25,000 pounds	752	925	123

There appears to be a slight positive correlation between weight per inch of tire width and tire thickness. In both less-than-capacity loads and loads in excess of rated capacity the average weights increase slightly with increased thickness of the tire for thickness up to 2.5 inches.

APPRAISAL OF VARIOUS MEASURES OF OVERLOADING

The purpose of load limitation is to prevent the needless destruction of the highways by excessively loaded trucks. Highways should be designed to carry the maximum economic load necessary to serve the type of traffic on the various classes of highways. The designing of a highway to carry excessively heavy loads which occur only at infrequent intervals, however, is uneconomic, as it results in increased construction costs with resulting increased service to only a small number of vehicles. The effect of heavy loading upon a highway is determined by two factors:

1. The gross weight of the motor truck or other vehicle.
2. The intensity of the load applied to a unit of surface, this intensity being usually measured in terms of weight per inch of tire width.

The simplest measure of overloading is the extent to which the load exceeds the rated capacity of the vehicle. The construction of vehicles, however, varies so greatly that this measure frequently does not determine accurately the effect of the vehicle upon the highway. Variation in the empty weight, in tire equipment, in spring equipment, in the ratio of sprung to unsprung weight, and in the normal distribution of weight between the front and rear axles of vehicles of the same rated capacity, weakens considerably the rated capacity as a measure of safe loading.

A second measure of overloading in common use is the extent to which the load exceeds a maximum gross load limitation. Such restrictions prevent the application of extremely heavy unit loads but do not prevent the application of excessively heavy loads per unit of surface. They permit excessive loading of the smaller trucks and may prohibit the economic use of trucks of larger capacity, although these larger trucks may be designed to carry the rated capacity of the truck without excessive loading per unit of highway surface.

A third measure is the limitation of the weight per inch of tire width. This measure prevents the application of intense weight per unit of surface; but such loading restrictions are very difficult of enforcement, requiring as they do the weighing of each wheel, the measurement of tire width, and the computation of the weight per unit of width.

The analyses of motor truck overloading on these three bases of measurement have been presented above. On the basis of rated capacity 30.2 per cent of all loaded trucks observed during the survey were found to be overloaded; on the basis of the 25,000-pound gross weight limitation 2.1 per cent were overloaded, and on the basis of 800 pounds per inch of tire width, channel measurement, 2.2 per cent were found to be overloaded.

These measures are not strictly comparable in that the rated capacity measure is based on all loaded trucks, the gross load measure is of necessity limited to trucks of 3½ tons and larger capacities, and the weight per inch of tire width measure is limited to trucks equipped with solid tires. This results in the elimination of the large majority of trucks of less than 2 tons capacity, since more than 90 per cent of all trucks under 2 tons capacity have pneumatic tires on both front and rear wheels.

It is also evident that the thickness of a solid tire has an important bearing on the effect which a given intensity of weight per unit of width will have upon the highway.[14]

It is generally agreed that the conservation of a highway investment requires:

1. The prohibition of excessively heavy gross loads.
2. The prohibition of excessive loads per unit of area in contact with the highway surface.
3. The prohibition of trucks equipped with tires of inadequate thickness of rubber.

The actual limits established will of necessity depend upon the type of highway construction, and the type of motor-truck transportation in the area under consideration. The proper limits can be determined only as the result of physical tests of the effect of various loads upon

[14] See article entitled "Motor truck impact as affected by tires, other truck factors, and road roughness," Public Roads, Vol. 7, No. 4, June 1926.

highway surfaces. A scientific plan of highway development should include the provision of the type of highway surface required by the economic trucking unit in the area. Until such a type of construction can be provided the prohibition of loads destructive to present highway types is justified.

The rated capacity of trucks is not under present conditions a satisfactory measure of loading limitations, though it does have the advantage of being easily enforced and with proper standardization of motor truck capacity rating could be made a satisfactory measure of loading.

HIGHWAY UTILIZATION

THE daily vehicle utilization of Connecticut highways is indicated by Figures 13 and 14. The relative importance of the principal highways of the State as motor-truck routes is further indicated by Figure 27 which shows the average daily net and gross tonnage of motor trucks on these highways. In general the highways carrying the greatest number of trucks per day are also the highways which carry the greatest gross and net tonnage; but the tonnage is influenced by the capacity of the trucks as well as by their number, and the effect of the greater proportion of large-capacity trucks on the main highways, as shown in Figure 20, is also indicated by the relatively greater tonnage on the same routes. The variation between the daily number of trucks and the daily tonnage is illustrated by a comparison of the number of trucks and the tonnage at stations 35, 11, 10, and 44 (Table 27). Station 11 is located on the Post Road west of New Haven, station 35 on the same route south of Hartford, station 10 is near Derby, and station 44 is near Glastonbury.

Table 27.—Comparison of the daily number of trucks, their capacity and gross and net tonnage at selected stations

Station	Total number of trucks per day	Net tons per day	Gross tons per day	Per cent ½–2½ ton trucks	Per cent 5–7½ ton trucks	Ratio of net tons to number of trucks	Ratio of gross tons to number of trucks
35	176	236	792	66. 3	22. 8	1. 34	4. 50
11	322	422	1, 445	66. 1	14. 4	1. 31	4. 49
10	466	399	1, 496	84. 5	7. 3	. 86	3. 21
44	230	194	726	82. 2	6. 0	. 84	3. 16

Net tonnage transported is the most reliable basis for the measurement of the service value of a highway for the transportation of commodities. As a basis of selection of pavement type and design to meet traffic requirements the daily number of trucks, capacity distribution, gross tonnage, and rear axle loading are the most reliable indices.

The 1,114 miles of improved highways in the State trunk-line system carry an average of 159,000 net ton-miles and 575,000 gross ton-miles of motor-truck traffic per day. During the year period—September, 1922, to September, 1923—these highways carried approximately 58,000,000 net ton-miles and approximately 210,000,000 gross ton-miles of truck traffic. During the same period the total vehicle utilization of the State system was approximately 414,000,000 vehicle-miles of which 59,700,000 were truck-miles and 354,300,000 were passenger car-miles. The State trunk highway system includes 7.2 per cent of the total highway mileage in the State. The State-aid system includes 4.3 per cent and the town roads 88.5 per cent of the total mileage of the State. No accurate data regarding the vehicle-mileage utilization of the State-aid and town highway systems are available; but on the basis of scattered data it is estimated that approximately 60 per cent of the total vehicle mileage is on the State highway system, and that the total annual vehicle-mileage utilization of all highways in Connecticut is therefore approximately 690,000,000 vehicle-miles.

The Federal-aid system of the State comprises 835 miles, the major part of which is included in the State highway system; but, as the latter includes only highways that have been actually constructed, not all of the approved Federal-aid system is included. Approximately 730 miles of the Federal-aid system were included in the survey; and practically all of this mileage is included in the

State highway system. The annual utilization of the 730 miles is approximately 313,000,000 vehicle-miles, of which approximately 46,000,000 are truck-miles and 267,000,000 passenger car-miles. These 730 miles, comprising 65.5 per cent of the 1,114 miles of the State highway system, carry 75.6 per cent of the passenger-car mileage and 77.1 per cent of the truck mileage. The greater traffic importance of that portion of the State system which is also a part of the Federal-aid system is indicated by the fact that the average utilization per mile of the Federal-aid system exceeds the average for the entire State system by 15.2 per cent.

Of the annual 354,300,000 passenger car-miles on the State system, 33.8 per cent, or approximately 119,800,000 passenger car-miles, represents the business use of passenger cars, and 66.2 per cent or approximately 234,500,000 passenger car-miles represents the nonbusiness use of passenger cars. The average trip mileage of passenger cars used for business purposes is considerably below the corresponding average for nonbusiness usage, as indicated by the analysis of the two kinds of usage presented in Table 28.

Of all passenger cars using the highways 44.2 per cent are business cars and 55.8 per cent nonbusiness cars. The variation between the proportion of business and nonbusiness usage on a vehicle basis and on a mileage basis is due to the shorter average trip mileage of business cars.

The percentages of all cars used for business and nonbusiness purposes, classified according to trip mileage, are shown in Table 29.

The number of passengers per car averages 2.7 persons for all passenger cars. For business cars the average is 1.8 persons, and for nonbusiness cars, 3.2 persons. The passenger mileage on the State highway system for the year period was 206,000,000 for business cars and 768,000,000 for nonbusiness cars or a total of 974,000,000 passenger-miles.

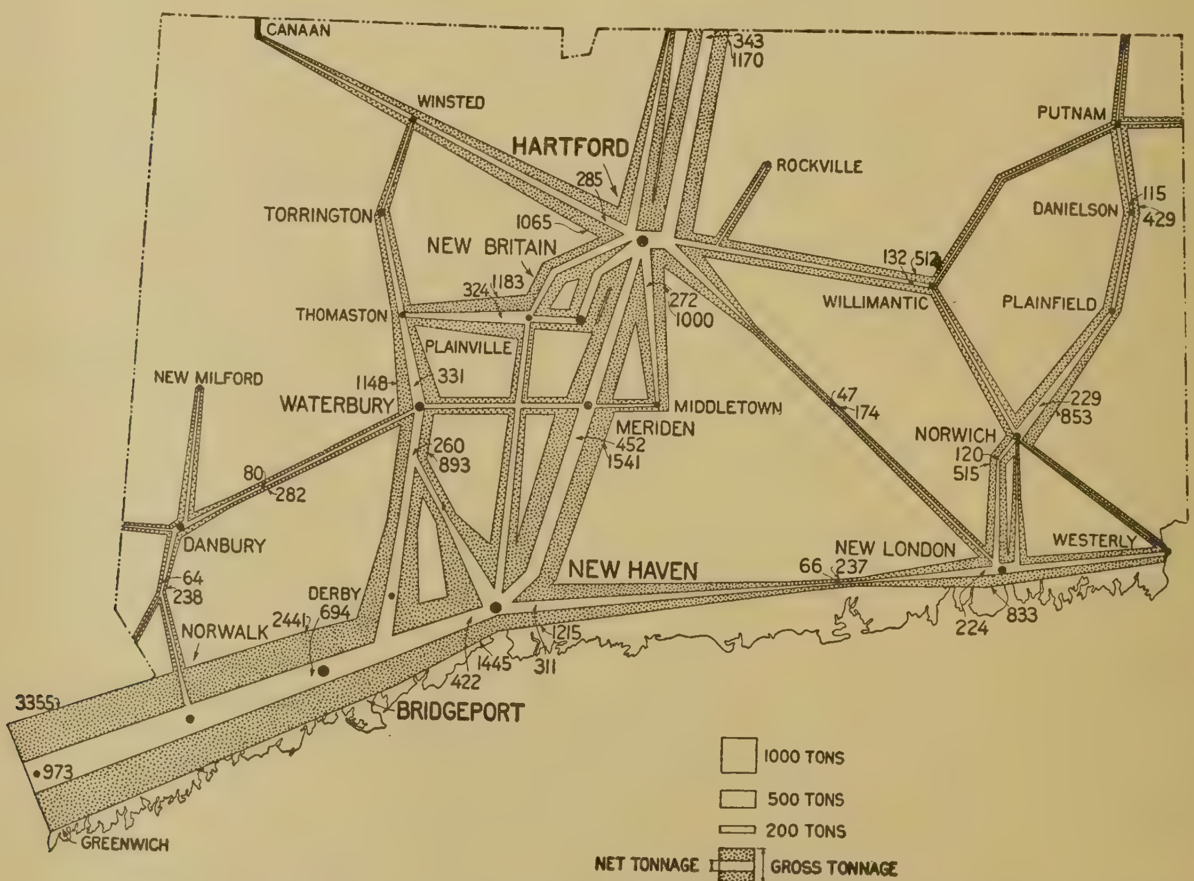


Fig. 27.—Average Daily Net and Gross Tonnage of Motor Trucks Using the Important Highways of Connecticut

Table 28.—Trip mileage of passenger cars used for business and nonbusiness purposes

Trip mileage	All passenger cars	Business cars	Nonbusiness cars
	Per cent	Per cent	Per cent
0–19	55. 7	65. 3	48. 0
20–39	16. 3	14. 4	17. 9
40–59	9. 2	8. 2	10. 1
60–79	5. 0	3. 9	5. 9
80–99	3. 6	1. 7	5. 1
100–149	4. 3	3. 3	5. 1
150–199	1. 7	1. 2	2. 1
200–299	2. 7	1. 5	3. 7
300–399	. 5	. 2	. 7
400–499	. 2	. 1	. 4
500 and over	. 8	. 2	1. 0
Total	100. 0	100. 0	100. 0

Table 29.—Percentages of all passenger cars used for business and nonbusiness purposes, classified according to trip mileage.

Trip mileage	Business cars	Nonbusiness cars
	Per cent	Per cent
0–19	52. 2	47. 8
20–39	39. 3	60. 7
40–59	39. 4	60. 6
60–79	34. 8	65. 2
80–99	21. 6	78. 4
100–149	34. 5	65. 5
150–199	30. 9	69. 1
200–299	24. 6	75. 4
300–399	17. 6	82. 4
400–499	17. 2	82. 8
500 and over	12. 6	87. 4
Total	44. 5	55. 5

THE SERVICE VALUE OF THE HIGHWAY SYSTEM

THE service value of a highway system on which the annual traffic is 414,000,000 vehicle-miles, involving 58,000,000 net ton-miles of commodities and 974,000,000 passenger-miles, is very large. The value of the service is reflected in a multitude of ways but there is no accurate method of measuring this value and expressing it in monetary terms. The costs of operating these vehicles are probably not less than 10 cents per vehicle-mile for passenger cars and 25 cents per vehicle-mile for trucks. The average gross weight of all trucks operated on the State highway system was found to be approximately 3½ tons. An operating cost of 25 cents per truck-mile is therefore only slightly over 7 cents per ton-mile.[15]

It may be assumed that the value of the highway service is 1 cent per passenger car-mile and 3 cents per truck-mile. These estimates must necessarily, on account of the lack of any accurate method of measuring highway service value, be assumptions; but they are conservative. The average net load of all trucks operating on the State highway system was found to be slightly less than 1 ton. Three cents per truck-mile is therefore a charge for highway service of only slightly over 3 cents for moving 1 ton of commodities 1 mile or less than 1 cent per gross ton-mile. As the average number of passengers per car is 2.7 persons, 1 cent per passenger car-mile is a charge for highway service of less than 0.4 of a cent per passenger-mile.

These values for highway service are considerably less than estimated differences in vehicle operating costs on improved and unimproved highways.[16] Toll rates on existing toll roads indicate that highway users are willing to pay considerably in excess of these amounts for the use of the toll road in preference to using the free roads with "slightly heavier grades and somewhat poorer surfaces." [17]

[15] The operating costs of a well-established commercial trucking company operating in Massachusetts, Rhode Island, and Connecticut and equipped with a fleet of 2 and 5 ton trucks, of which the majority were of the 5-ton capacity, averaged during a year period approximately 55 cents per truck-mile. Analyses of motor trucking rates indicate a transportation charge ranging from 13.4 cents to 18.3 cents a ton-mile. These averages represent only a small number of samples and are therefore perhaps not so reliable as a general average. They represent rates for hauls considerably longer than the average haul of motor-truck freight in Connecticut and also hauling in trucks of larger capacity. Trucking rates can never exceed the value of the service rendered; and, under present competitive conditions in the commercial trucking industry, the level of rates is undoubtedly considerably below the value of the service. These facts indicate that the assumed service value of 25 cents per truck-mile is conservative.

[16] See Bul. 69, Iowa State College of Agriculture and Mechanic Arts, Highway transportation costs, by T. R. Agg and H. S. Carter, p. 20.

[17] Bul. 4, University of Tennessee Engineering Experiment Station, Highway transportation, by N. W. Dougherty, pp. 53 and 107–8.

Applying these assumed values of 1 cent per passenger car-mile and 3 cents per truck-mile to the traffic on the 1,114 miles of the State trunk highway system, an estimated service value of the highway system can be obtained. As stated above the annual vehicle mileage on this system during the year period—September, 1922, to September, 1923—was approximately 414,000,000 vehicle-miles, of which 59,700,000 were truck-miles and 354,300,000 were passenger car-miles. On this basis of valuation the annual service value of the system is $1,791,000 for truck traffic and $3,543,000 for passenger car traffic, a total of $5,334,000 for the system.

A valuation based on motor-vehicle operating costs, however, does not represent the total service value produced by the highway system and the vehicles using the highways. Highway improvements increase real property values. Highway transportation adds time utility to the value of goods by the rapid movement at the time of demand and also produces place utility by making goods available for use by transporting them from the place of supply to the place of demand.

The 1923 salvage value of the 1,114 miles of improved highways on the State trunk-line system, including bridges but exclusive of right of way, is estimated by the Connecticut State Highway Commission at approximately $23,000,000. Based on the above estimate of the service value of the highway system to highway users, and without considering the additional service value indicated above, the State trunk highway system earns an annual return of approximately 23 per cent on the investment.

CONNECTICUT AND FOREIGN MOTOR VEHICLE USE OF THE STATE HIGHWAY SYSTEM

THE utilization of Connecticut highways by motor vehicles of foreign registration forms an important part of both motor truck and passenger car traffic. Trucks of foreign registration were 10.9 per cent of all trucks recorded, as shown by the distribution of trucks by State of registration and area of operation in Table 30.

The utilization on a ton-mileage basis of Connecticut highways by trucks of foreign registration is considerably higher than 10.9 per cent, on account of the fact that the average trip mileage of the foreign trucks is higher than that of the Connecticut trucks. The average trip mileage of trucks of Connecticut registration was found to be 15.7 miles and that of trucks of foreign registration was 71.9 miles. But as a part of the trip mileage in each case was over the highways of other States, its elimination leaves an average mileage on Connecticut highways for trucks of Connecticut registration of 14 miles and for trucks of foreign registration of 40 miles. The average trip mileage of motor trucks classified by State of registration and area of operation is shown in Table 31.

Table 30.—Distribution of motor trucks by State of registration and area of operation

State of registration and area of operation	Per cent of all trucks
CONNECTICUT	
Wholly within Connecticut	80. 2
Between Connecticut points and foreign points	8. 7
Between foreign points via Connecticut highways	. 2
All areas	89. 1
FOREIGN	
Wholly within Connecticut	. 9
Between Connecticut points and foreign points	8. 2
Between foreign points via Connecticut highways	1. 8
All areas	10. 9
Total, all areas	100. 0

The foreign trucks not only have a greater average trip mileage but also carry a greater

tonnage per truck than the Connecticut trucks. This results from the greater proportion of large capacities among the trucks of foreign registration. The loading of Connecticut and foreign trucks of the same capacity is very similar. The distribution of foreign and Connecticut trucks by capacities is shown in Table 32.

The effect upon the ton-mile utilization of Connecticut highways of the longer average trip mileage of trucks of foreign registration and of the relatively greater number of large-capacity trucks among the trucks of foreign registration is shown in Table 33.

Thus it will be seen that trucks of Connecticut registration operating wholly within the State are 80.2 per cent of the total number of trucks, but furnish only 48 per cent of the total ton mileage. Trucks of foreign registration operating between foreign points via Connecticut highways, which are only 1.8 per cent of the total number of trucks, furnish 17.1 per cent of the total ton mileage.

The importance of the foreign traffic on Connecticut highways is clearly indicated in Table 33, in that it shows that trucks of foreign registration furnish almost one-third of the total ton mileage of truck traffic. The importance of what may be termed a "cross-over" movement, the movement between foreign

Table 31.—Average trip mileage and mileage on Connecticut highways of Connecticut and foreign motor trucks

State of registration and area of operation	Average trip mileage per truck	Average mileage per truck on Connecticut highways
CONNECTICUT		
Wholly within Connecticut	12. 1	12. 1
Between Connecticut and foreign points	45. 6	28. 9
Between foreign points via Connecticut highways	180. 3	107. 1
All areas	15. 7	14. 0
FOREIGN		
Wholly within Connecticut	13. 1	13. 1
Between Connecticut and foreign points	47. 1	27. 1
Between foreign points via Connecticut highways	210. 8	110. 3
All areas	71. 9	40. 0
All trucks, all areas	21. 9	16. 8

Table 32.—Distribution of loaded trucks of Connecticut and foreign registration by capacities

Truck capacity (tons)	Connecticut registration (per cent)	Foreign registration (per cent)
½	25. 3	14. 2
¾	4. 1	4. 0
1	17. 7	10. 9
1¼	13. 0	7. 8
1½	6. 4	3. 3
2	9. 8	13. 0
2½	3. 8	3. 9
3	1. 6	1. 7
3½	7. 3	9. 2
4	. 7	1. 2
5	9. 0	26. 6
5½	. 4	1. 4
6	. 3	. 5
6½	. 5	1. 2
7½	. 1	1. 1
Total	100. 0	100. 0

Table 33.—Distribution of motor truck gross ton mileage on Connecticut highways by State of registration and area of operation

State of registration and area of operation	Per cent of total ton-miles
CONNECTICUT	
Wholly within Connecticut	48. 0
Between Connecticut points and foreign points	17. 5
Between foreign points via Connecticut highways	1. 7
All areas	67. 2
FOREIGN	
Wholly within Connecticut	0. 8
Between Connecticut points and foreign points	14. 9
Between foreign points via Connecticut highways	17. 1
All areas	32. 8

points via Connecticut highways, is also indicated. This movement is 18.8 per cent of the total ton mileage and 17.1 per cent is produced by trucks of foreign registration. It is a type of movement that is peculiar to highways in areas that serve as connections between important centers of population and industry. In Connecticut it is produced largely by the movement between New York City and the larger cities of Massachusetts and Rhode Island.

The normal interchange of trucking between two States will tend to be divided equally among trucks registered in each of the two States. This is indicated by Table 30, in that the Connecticut trucks transporting goods between Connecticut and foreign points are shown to be 8.7 per cent of the total, and the foreign trucks transporting goods between Connecticut and foreign points are 8.2 per cent of the total number of trucks. The similarity of average trip mileage and mileage on Connecticut highways of these classes of movement (Table 31) is additional proof of this fact.

Passenger cars of foreign registration were 21.1 per cent of all passenger cars recorded. (Table 35.) The average trip mileage on Connecticut highways of passenger cars of Connecticut and foreign registration is shown in Table 34.

Table 34.—Average trip mileage on Connecticut highways of passenger cars of Connecticut and foreign registration

Area of operation and State of registration	Type of usage	Average mileage on Connecticut highways
INTERSTATE		
Connecticut	Business	58. 8
Do	Nonbusiness	70. 0
Foreign	Business	72. 3
Do	Nonbusiness	90. 4
INTRASTATE		
Connecticut	Business	18. 8
Do	Nonbusiness	26. 7
Foreign	Business	32. 7
Do	Nonbusiness	36. 1

Table 35.—Passenger-car, passenger car-mile, and passenger-mile utilization of Connecticut highways

Area of operation, State of registration, and type of use	Percentage of passenger cars	Percentage of passenger-car-miles	Percentage of passenger-miles
INTERSTATE			
Connecticut:			
Business	2. 9	4. 5	3. 1
Nonbusiness	4. 5	8. 4	9. 8
Foreign:			
Business	5. 7	10. 9	6. 9
Nonbusiness	12. 3	29. 6	34. 3
INTRASTATE			
Connecticut:			
Business	34. 1	17. 1	10. 8
Nonbusiness	37. 4	26. 6	32. 6
Foreign:			
Business	1. 5	1. 3	0. 8
Nonbusiness	1. 6	1. 6	1. 7
TOTAL			
Business	44. 2	33. 8	21. 6
Nonbusiness	55. 8	66. 2	78. 4
Connecticut	78. 9	56. 6	56. 3
Foreign	21. 1	43. 4	43. 7
Interstate	25. 4	53. 4	54. 1
Intrastate	74. 6	46. 6	45. 9

It will be noted that in each case the average trip mileage on Connecticut highways of passenger cars of foreign registration is greater than that of the corresponding type of passenger cars of Connecticut registration. The car-mile use of Connecticut highways by cars of foreign registration is therefore greater than the corresponding use by cars of Connecticut registration. This is indicated by the fact that while 21.1 per cent of all cars are of foreign registration, 43.4 per cent of the total passenger-car mileage is produced by cars of foreign registration (Table 35).

The cars of Connecticut and foreign registration are very similar in respect to the number of passengers they carry but differ markedly with respect to their use for business or nonbusiness purposes. This is shown by Table 35 and in the following tabulation.

Average number of passengers carried by various classes of cars

	Passengers per car
All Connecticut cars	2. 71
All foreign cars	2. 77
Connecticut business cars	1. 80
Connecticut nonbusiness cars	3. 52
Foreign business cars	1. 83
Foreign nonbusiness cars	3. 26

The distribution of passenger cars, passenger-car mileage and passenger mileage by areas of operation, State of registration, and type of usage are shown in Table 35.

The effect of the greater average mileage of cars on interstate trips as compared with cars operating wholly within the State, and cars of foreign registration as compared with cars of Connecticut registration is clearly evident. The larger number of passengers in cars of nonbusiness use is also evident. Cars of Connecticut registration are 78.9 per cent of all cars operating but furnish only 56.6 per cent of the total passenger-car mileage. Nonbusiness cars are 55.8 per cent of all cars operating and produce 78.4 per cent of the total passenger-miles. Cars in interstate operation are 25.4 per cent of the total number of cars and produce 53.4 per cent of the total passenger-car mileage, and 54.1 per cent of the total passenger mileage.

THE TRANSPORTATION OF COMMODITIES BY MOTOR TRUCK

THE importance of the motor truck in the transportation system of Connecticut has been clearly shown in the previous sections of this report. In 1923 there were 29,140 and in 1924 33,776 motor trucks registered in the State. These motor trucks were in constant use carrying commodities over Connecticut highways and streets. During the period—September, 1922, to September, 1923—the haulage of these commodities over the 1,114 miles of the State highway system amounted to approximately 58,000,000 ton-miles and the inclusion of other highways and city streets would substantially increase this amount.

A transportation agency of this size warrants a rather detailed analysis of its organization, scope, methods of operation, commodities carried, and its place in the general field of transportation.

The transportation of commodities by motor truck is primarily a complete short-haul movement in vehicles owned by the shipper or consignee of the goods transported. A number of commercial motor-trucking organizations are operating in the State, but they carry a relatively small part of the total tonnage transported by motor truck. Since the predominating part of this tonnage is transported in vehicles owned by the shipper or consignee, no high degree of organization of the industry can be expected. The regularity of the movement depends largely upon the daily volume of goods available for shipment and the character of the truck owner's business. The regularity of truck movement measured on the basis of number of trips per week of each truck observed is shown in Table 36.

It is evident that more than 50 per cent of the trucks average three trips per week or less. This represents the large volume of miscellaneous or irregular, unorganized motor trucking.

Table 36.—Motor-truck trips per week

Trips per week	Trucks	
	Number	Per cent
Less than 1	2, 933	17. 0
1	2, 501	14. 5
2	2, 296	13. 3
3	1, 852	10. 8
4	659	3. 8
5	386	2. 3
6	3, 515	20. 4
7	1, 439	8. 4
8	98	. 6
9 and over	1, 533	8. 9
Total	17, 212	100. 0

The largest single class includes the trucks that make six trips per week, 20.4 per cent of all the trucks observed, having a regular daily movement made up very largely of the distri-

bution of consumption goods and to a lesser degree of the marketing of agricultural products such as milk, fruits, and vegetables. In this group the average haul of 88.5 per cent of the trucks is less than 30 miles, and of 97.4 per cent less than 50 miles.

Trucks making nine trips or more per week constitute 8.9 per cent of the total number observed, and make up a class the movement of which is largely a short haul of building materials such as gravel, sand, stone, cement, and lumber. Of these trucks 79.7 per cent have an average haul of less than 10 miles and 94.7 per cent an average haul of less than 20 miles.

Even within that small part of motor trucking which is carried on by commercial truckers, the lack of organization is apparent. The majority of commercial trucking organizations are small, and only a few of them have the equipment and organization required to furnish efficient and reliable transportation service. Relatively few organizations have financial stability, and few keep complete records of their trucking costs. Until the cost of performing the service is accurately determined, so that the trucker will be able to distinguish between profitable and unprofitable types of business, financial stability can not be attained.

Competition in the industry is severe and is due primarily to the fact that a motor-trucking company can be established with a small investment of capital. Trucking equipment can be purchased with a small initial payment, and the possession of the equipment and payment of a vehicle license fee enables the purchaser to engage in the motor-trucking business in many States.

The sharp competition has, in frequent instances, resulted in the establishment of trucking rates which are below gross operating costs; and frequently, also, the rates have been established on the basis of existing railway and competing trucking rates, and may have little relation to actual trucking costs.

A prerequisite to the establishment of commercial motor trucking on a sound basis is the determination of rates on the basis of operating costs. Such rates can be established only when accurate costs have been determined and the industry is regulated to prevent destructive competition.

Motor-truck transportation in Connecticut is of three principal types.

1. Transportation within the market and trading area of a city or town, including—
   (a) Distribution of commodities from wholesaler to retailer, and from retailer to consumer.
   (b) Marketing of commodities produced in the area, and
   (c) Pick-up and delivery service between railroad or water terminals and shipper and consignee.

This movement is purely local, the major part of it being within the city or town. It uses the rural highways only in so far as the market or trade area of the city extends beyond its political limits.

2. Complete transportation from the shipper's place of business to the consignee's place of business for comparatively short-haul shipments. This type of transportation is interurban rather than local or suburban in character and is generally limited to distances of less than 40 miles.

3. Comparatively long-distance transportation, including—
   (a) The transportation of specialized commodities, notably those which require a special preparation for shipment by rail or water that can be avoided by motor-truck shipment; and those which, because of their high value or their perishability, require rapid-delivery service; and
   (b) Emergency transportation during periods of congestion and embargoes on other transportation facilities.

Although no exact line can be drawn between these types of motor-truck transportation on the basis of length of haul, it may be added that the local and suburban traffic (type 1) is strictly a short haul; that the interurban traffic between neighboring centers of population (type 2) varies with the distance between the centers of population, but in an area like Connecticut is largely a short haul; and that the long-distance hauling (type 3) is predominantly the movement of specialized commodities.

The distribution of the net tonnage transported by motor truck over the Connecticut State highway system according to the length of haul is shown in Table 37 and Figure 28.

From this table it is evident that of the total net tonnage transported over the State highway system more than one-third is moved distances of less than 10 miles, approximately

Table 37.—Distribution of net tonnage of commodities transported by motor truck over the Connecticut State highway system by length of haul

Length of haul (miles)	Proportion of total net tonnage (per cent)	Length of haul (miles)	Proportion of net total tonnage (per cent)
0–9	36. 3	70–79	2. 6
10–19	19. 2	80–89	. 8
20–29	11. 6	90–99	1. 0
30–39	9. 1	100 and over	8. 6
40–49	4. 0		
50–59	4. 6	Total	100. 0
60–69	2. 2		

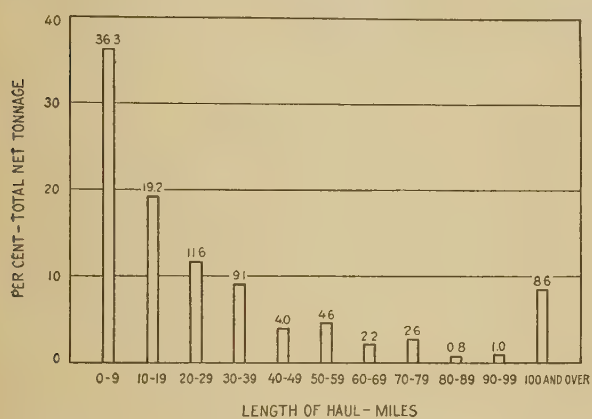


Fig. 28.—Distribution of Net Tonnage of Commodities Transported by Motor Trucks Over the Connecticut State Highway System According to Length of Haul.

two-thirds is moved distances of less than 30 miles, and only 15.2 per cent is moved distances of 60 miles and over. The table includes commodities transported over the State system only and excludes the large volume of motor-truck tonnage which is transported over city streets. The latter movement is almost exclusively within the 0 to 9 mile zone and its inclusion would greatly increase the proportion of the total in this group.

The percentage of total net tonnage transported 100 miles or over (8.6 per cent) on the Connecticut State highway system is probably higher than would be found on highways of other States, because of the location of the State between the densely populated and highly industrialized sections of New York, Massachusetts, and Rhode Island.

Approximately 350 distinct commodities were recorded on trucks using the State highway system during the period of observation, but of the total net tonnage 69 per cent was made up of manufactured goods. The distribution by types of commodities is shown in Table 38 and Figure 29.

Table 38.—Types of commodities transported by motor truck on the State highway system

Type of commodity	Per cent of total net tonnage
Products of agriculture	7. 2
Products of animals	9. 4
Products of mines	9. 6
Products of forests	4. 8
Manufactures	69. 0
Total	100. 0

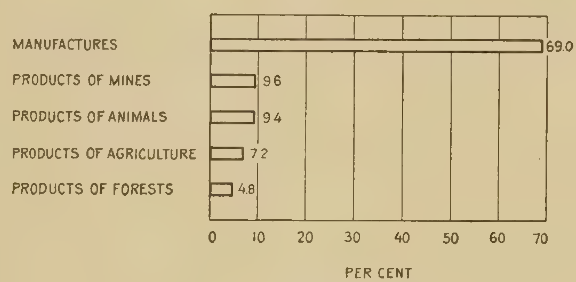


Fig. 29.—Classes of Commodities Transported by Motor Trucks Over the Connecticut State Highway System

Table 39 indicates that, of the large number of different commodities transported by motor truck on the State system, 25 commodities made up 65.6 per cent of the total net tonnage. The five most important commodities are 25.9 per cent of the total and the first 15 account for 52.9 per cent. It will be observed also that of the first 15 commodities 7 are foodstuffs, and that these represent 22.5 per cent of the total net tonnage. General express, mixed loads which can not be classified as any particular commodity, consists in part of foodstuffs. The miscellaneous commodities, 34.4 per cent of the total net tonnage, also include a considerable amount of foodstuffs. The addition of these commodities to the foodstuffs listed would increase their total to approximately 40 per cent of the total net tonnage.

The length of haul and the average unit load of the different commodities varies consider-

Table 39.—Principal commodities transported by motor truck on State highway system

Commodity	Per cent of total net tonnage
Groceries	6. 8
Gravel, sand, and crushed rock	5. 3
General express	4. 8
Gasoline	4. 5
Household goods (used)	4. 5
Coal	3. 3
Lumber	3. 3
Bread and bakery goods	3. 0
Meat, fresh	2. 9
Milk, fresh	2. 7
Fruits	2. 7
Brass, copper and lead	2. 5
Beverages	2. 4
Textiles	2. 2
Ice cream	2. 0
Iron and steel bar	1. 8
Brick	1. 5
Feed and grain	1. 5
Furniture (new)	1. 4
Vegetables	1. 3
Paper	1. 2
Wire	1. 1
Ice	1. 0
Tires, rubber	1. 0
Wood, cord, and kindling	. 9
Miscellaneous commodities	34. 4
Total	100. 0

ably. Of the materials hauled 9 miles and less, gravel, sand, and stone are first in importance; in the 10 to 19 mile haul they rank third in importance, and for longer hauls they are not among the important commodities. Coal appears as an important commodity only in the shortest haul groups, groceries in all haul groups up to 70 miles, and gasoline among the commodities hauled all distances up to 30 miles. The commodities of greatest importance in the long-haul groups are household goods (used), textiles, rubber tires, and crude rubber. Household goods increase in relative importance with increase in the distance hauled, constituting 5.1 per cent of the movement from 40 to 49 miles and 23.5 per cent of the haulage for distances of 100 miles and more. Rubber tires and crude rubber appear among the important commodities only for hauls of 100 miles or more, indicating the very specialized character of the movement over such long distances.

The movement of foodstuffs, consisting largely of retail distribution and the marketing of such products as milk, is predominantly a small-truck movement. Household goods are transported chiefly in trucks of 1½ to 4 tons capacity, and constitute 11.7 per cent of all goods transported in 2½-ton trucks. Gasoline is hauled largely in trucks of from 2 to 4 tons capacity, and gravel, sand, stone, brick, and cement are hauled largely in trucks of 3½-ton and larger capacities. Textiles, metal products, and paper (largely news print) are also hauled in large-capacity trucks.

COMPARISON OF MOTOR TRUCK AND RAIL TONNAGE

The relative importance of the highway transportation of commodities of various classes, with respect to the rail movement of the same classes of goods, is indicated in Table 40 by a comparison of the tonnage of freight transported by motor truck and by rail between selected points during the months of January and August, 1923.

The rail movements used for comparison were all made by the New York, New Haven & Hartford Railroad, and with the possible exception of the New York-Springfield movement the tonnage given represents the total rail freight between the several points during the selected periods.[18]

The points between which the two movements are compared represent distances varying from 17 to 140 miles, and all points compared have direct connection both by rail and highway, the highways represented being the most important trucking routes in the State of Connecticut. Several of the points compared have water connections as well as rail and highway connections and a considerable amount

[18] All rail tonnage statistics used in this section of the report were furnished by the New York, New Haven & Hartford Railroad Co.

Table 40.—Tonnage of freight transported by motor truck and by the New York, New Haven & Hartford Railroad between selected points during the months of January and August, 1923 [1]

Type of transportation	All freight	Products of agriculture	Products of animals	Products of mines	Products of forests	Manufactures
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Between Ansonia-Derby [2] and New York City:						
Motor truck	615. 0	--------	87. 0	--------	--------	528. 0
Rail, l. c. l	501. 1	1. 7	4. 9	3. 6	8. 2	482. 7
Rail, carload	4, 188. 8	20. 2	--------	--------	--------	4, 168. 6
Between Bridgeport and New York City:						
Motor truck	6, 570. 0	931. 0	416. 0	16. 0	102. 0	5, 105. 0
Rail, l. c. l	603. 9	24. 4	4. 2	12. 8	7. 2	555. 3
Rail, carload	4, 991. 0	281. 4	29. 2	54. 6	233. 0	4, 392. 8
Between Hartford and New York City:						
Motor truck	1, 722. 0	53. 0	138. 0	2. 0	20. 0	1, 509. 0
Rail, l. c. l	1, 347. 6	163. 0	84. 2	18. 5	4. 9	1, 077. 0
Rail, carload	4, 425. 7	896. 5	37. 9	61. 2	147. 9	3, 282. 2
Between New Haven and New York City:						
Motor truck	3, 039. 0	266. 0	490. 0	--------	10. 0	2, 273. 0
Rail, l. c. l	927. 7	19. 5	12. 4	8. 4	45. 3	842. 1
Rail, carload	9, 886. 3	1, 222. 8	817. 6	100. 6	118. 0	7, 627. 3
Between Waterbury and New York City:						
Motor truck	1, 108. 0	200. 0	87. 0	8. 0	--------	813. 0
Rail, l. c. l	2, 228. 2	42. 3	45. 4	12. 8	36. 4	2, 091. 3
Rail, carload	9, 430. 8	307. 0	17. 4	--------	45. 0	9, 061. 4
Between Springfield and New York City:						
Motor truck	1, 060. 0	29. 0	31. 0	3. 0	12. 0	985. 0
Rail, l. c. l	2, 305. 2	277. 3	91. 0	11. 0	22. 0	1, 903. 9
Rail, carload	3, 429. 9	863. 6	91. 6	91. 0	162. 9	2, 220. 8
Between New Haven and Bridgeport:						
Motor truck	6, 756. 0	527. 0	1, 050. 0	253. 0	159. 0	4, 767. 0
Rail, l. c. l	80. 7	6. 2	--------	(3)	--------	74. 5
Rail, carload	2, 148. 6	87. 6	6. 0	53. 4	--------	2, 001. 6
Between New Haven and Hartford:						
Motor truck	4, 195. 0	186. 0	996. 0	151. 0	62. 0	2, 800. 0
Rail, l. c. l	165. 3	14. 4	1. 7	1. 9	4. 4	142. 9
Rail, carload	12, 677. 6	25. 4	12. 2	12,085.2	27. 6	527. 2
Between Hartford and Springfield:						
Motor truck	3, 667. 0	196. 0	500. 0	--------	119. 0	2, 852. 0
Rail, l. c. l	399. 3	27. 7	6. 9	0. 6	0. 1	364. 0
Rail, carload	3, 718. 0	41. 0	31. 0	--------	18. 2	3, 627. 8
Between Hartford and Waterbury:						
Motor truck	1, 789. 0	91. 0	111. 0	31. 0	11. 0	1, 545. 0
Rail, l. c. l	91. 5	9. 4	4. 4	--------	--------	77. 7
Rail, carload	150. 4	25. 4	11. 0	--------	18. 0	96. 0
Between Bridgeport and Waterbury:						
Motor truck	2, 946. 0	139. 0	48. 0	--------	51. 0	2, 708. 0
Rail, l. c. l	39. 7	0. 3	--------	--------	--------	39. 4
Rail, carload	1, 154. 8	22. 0	--------	504. 7	--------	628. 1

[1] Rail tonnage includes freight between the terminals of the New York, New Haven & Hartford R. R. in each of the selected towns, and does not include express or parcel-post movements. New York City includes the following terminals: Pier 37, Pier 70, Harlem River, Bush Terminal, New York Dock, Brooklyn Eastern District, and Jay Street. Motor-truck tonnage includes freight between the selected towns. New York City includes Brooklyn and Jersey City; and also points from which freight must pass through New York City to reach its destination. Freight from the latter points is less than 7 per cent of the total from New York City.

[2] The Ansonia-Derby tonnage includes the sum of the tonnages between Ansonia and New York, and Derby and New York, for both truck and rail tonnage.

[3] Less than 0.1 ton.

of tonnage between them is transported by water.

The rail distances between the several points vary from approximately 17 miles to 134 miles, and the highway mileage varies but little from the rail mileage; but, because the rail tonnage is transported from various terminals and the truck tonnage is collected and delivered in all parts of the selected cities, no accurate mileage can be computed. However, on the basis of the approximate mileage, the comparison presented in Table 41 does show the greater importance of the truck traffic over the shorter distances.

The decrease in the percentage of net tonnage transported by motor truck with the increase in mileage is very pronounced but accompanied by some irregularities. These irregularities are explained by distribution methods and the presence or absence of water transportation. The low percentage of truck tonnage between Hartford and Springfield is accounted for by the large rail carload movement of refined petroleum and its products between these points. The low percentage of truck tonnage between New Haven and Hartford is accounted for by the large rail carload movement of coal. The movement of these commodities between other points shown in the table is comparatively small.

The higher percentage of truck tonnage between New York City and Bridgeport, New Haven, and Hartford, as compared with the movement between New York City and Ansonia-Derby and Waterbury is undoubtedly explained by the water transportation between the former points. Between New York City and Springfield, Mass., it is probable that rail tonnage is also carried by rail carriers other than the New York, New Haven & Hartford.

As motor-truck freight is primarily a package, or small unit shipment, it is more strictly comparable with rail l. c. l. freight than with all rail freight, and comparison of these two movements is therefore shown in Table 42.

Of all package freight the motor truck carries over 90 per cent between points less than 60 miles apart. Between points over 60 miles apart the percentage varies considerably, but the tendency toward relatively decreasing truck tonnage with the increase in distance is very apparent.

The importance of the motor truck in the transportation of products of agriculture and products of animals is even more apparent. These classifications include a large part of the movement of perishable foodstuffs. For products of animals the motor truck tonnage greatly exceeds the rail l. c. l. tonnage between all points analyzed except New York City and Springfield, a distance of approximately 134 miles, and exceeds the total rail tonnage between all points except New York City and Springfield, and New York City and New Haven. The large car-lot movement of these

Table 41.—Comparison of rail and truck tonnage between selected points

Terminal points		Mileage		Distribution of total tonnage			
		Highway	Rail	Motor truck	Rail, l. c. l.[1]	Rail, c. l.[2]	Total
				Per cent	*Per cent*	*Per cent*	*Per cent*
New Haven	Bridgeport	18	17	75. 2	0. 9	23. 9	100. 0
Hartford	Springfield	27	25	47. 1	5. 1	47. 8	100. 0
do	Waterbury	33	31	88. 1	4. 5	7. 4	100. 0
Bridgeport	do	37	32	71. 1	1. 0	27. 9	100. 0
New Haven	Hartford	40	37	24. 6	1. 0	74. 4	100. 0
New York City	Bridgeport	58	56	54. 0	5. 0	41. 0	100. 0
Do	Ansonia-Derby	72	70	11. 6	9. 4	79. 0	100. 0
Do	New Haven	75	72	21. 9	6. 7	71. 4	100. 0
Do	Waterbury	93	88	8. 7	17. 5	73. 8	100. 0
Do	Hartford	115	109	23. 5	17. 9	58. 6	100. 0
Do	Springfield	142	134	15. 6	33. 9	50. 5	100. 0

[1] Less than carload, package freight.
[2] Carload freight.

products between New York City and New Haven is largely accounted for by the fact that New Haven is the wholesale distribution market for a considerable area.

In the haulage of products of agriculture the motor-truck tonnage exceeds the rail l. c. l. tonnage for all hauls analyzed except the New York-Springfield, the New York-Hartford, and the New York-Ansonia-Derby. Between New York City and Hartford more than one-half of the rail l. c. l. tonnage of agricultural products is made up of tobacco. The total rail tonnage—carload and l. c. l.—exceeds the motor truck tonnage of these products between New York City and all points analyzed except Bridgeport, that is, for all distances over 60 miles; but the motor-truck tonnage exceeds the total rail tonnage of products of agriculture for all distances less than 60 miles.

Of manufactures the motor-truck tonnage exceeds the rail l. c. l. tonnage between all points analyzed except New York City and Springfield, and New York City and Waterbury; but the total rail tonnage exceeds that of the motor truck for all distances over 60 miles and also between Hartford and Springfield, a distance of approximately 25 miles. Between the latter points, however, 3,312 tons of the total of 3,627.8 tons, or over 90 per cent of the carload tonnage of manufactures, consists of refined petroleum and its products.

The importance of the motor truck in the transportation of commodities is clearly indicated by the above comparisons, which warrant the following conclusions:

1. A very considerable part of the package freight between origins and destinations in the Connecticut territory less than 50 miles apart is transported by motor truck.

2. As distance between origin and destination increases transportation by motor truck becomes of less importance.

3. The ratio of motor-truck freight to rail freight between two points varies greatly with distribution and marketing practices. Cities which are distributing points for surrounding areas receive a larger amount of freight in bulk lots, such as rail carload shipments, than cities which distribute to the local market alone.

4. For origins and destinations between which the exchange of freight includes bulk commodities, such as coal and oil, the tonnage transported by motor truck compared with total rail tonnage is relatively small. As such commodities are a necessary part of the freight into nearly all cities, motor-truck freight becomes a relatively small part of total freight.

In the transportation of package freight, particularly of certain classes, such as foodstuffs and perishables, the motor truck is undoubtedly competing with rail l. c. l. service and with express service between the points compared. With regard to this competition the following points must be considered:

1. The area under consideration is one of the most highly developed trucking areas in the country. The actual points between which tonnage is compared are located on the most important motor-trucking routes in the area, and the comparison therefore represents the maximum development of motor-truck transportation rather than the average.

2. Motor-truck transportation between the points compared and other similar points is but a small part

Table 42.—Comparison of motor truck and rail l. c. l. tonnage between selected points

Terminal points		Mileage		Distribution of truck and rail l. c. l. tonnage		
		Highway	Rail	Truck	Rail l. c. l.	Total
				Per cent	*Per cent*	*Per cent*
New Haven	Bridgeport	18	17	98. 8	1. 2	100. 0
Hartford	Springfield	27	25	90. 2	9. 8	100. 0
Do	Waterbury	33	31	95. 1	4. 9	100. 0
Bridgeport	do	37	32	98. 7	1. 3	100. 0
New Haven	Hartford	40	37	96. 2	3. 8	100. 0
New York City	Bridgeport	58	56	91. 6	8. 4	100. 0
Do	Ansonia-Derby	72	70	55. 1	44. 9	100. 0
Do	New Haven	75	72	76. 6	23. 4	100. 0
Do	Waterbury	93	88	33. 2	66. 8	100. 0
Do	Hartford	115	109	56. 1	43. 9	100. 0
Do	Springfield	142	134	31. 5	68. 5	100. 0

of the total motor-truck tonnage in the area. Of the total tonnage transported by motor truck over the Connecticut State highway system, 36.3 per cent moves less than 10 miles and 55.5 per cent less than 20 miles. Motor truck transportation in Connecticut is therefore essentially a local distribution of goods.

The predominance of local motor-truck traffic is also indicated by the analysis of motor-truck tonnage originating at and destined to Bridgeport, which is presented in Table 43.

Table 43.—Distribution of net tonnage of motor-truck freight originating at and destined to Bridgeport, according to length of haul

Length of haul (miles)	Proportion of net tonnage	
	Originating at Bridgeport	Destined to Bridgeport
	Per cent	*Per cent*
0–9	38. 9	27. 6
10–19	23. 5	23. 7
20–29	10. 6	10. 2
30–39	8. 8	9. 6
40–49	2. 0	3. 2
50–59	12. 2	21. 8
60–69	1. 5	1. 7
70–79	. 3	. 5
80–89	. 7	. 5
90–99	. 2	. 4
100 and over	1. 3	. 8
Total	100. 0	100. 0

The distribution of motor-truck tonnage to and from Bridgeport is similar to the distribution for the entire State, except for the unusual importance in the Bridgeport traffic of the 50 to 59 mile hauls. This variation indicates clearly the influence of traffic between Bridgeport and New York City, yet even the influence of the metropolis operates to increase the percentage of 50 to 59 mile shipments from Bridgeport only to 12 per cent of the total. It must also be borne in mind that the tonnage data here presented represent only the tonnage moved to and from Bridgeport over highways included in the State highway system. Although these are the most important highways leading into the city, the inclusion of other roads would increase the total tonnage, particularly in the short-haul zones, and the addition of truck tonnage carried exclusively over city streets would also decrease the relative importance of the comparatively long-distance tonnage.

Bridgeport, moreover, marks rather definitely the limit of the general trucking operation from New York City. Reference to Tables 40 and 42 will show that between New York and Bridgeport, 58 miles, the motor-truck tonnage is more than ten times the rail l. c. l. tonnage, whereas between, New York and New Haven, an increase of 17 miles, the motor-truck tonnage is only about three and one-third times the rail l. c. l. tonnage, and between New York and Waterbury, 35 miles beyond Bridgeport, the truck tonnage is less than one-half of the rail l. c. I. tonnage. This table also indicates that the motor-truck tonnage between New York and Bridgeport is more than double the tonnage similarly moved between New York and New Haven, which has a larger population than Bridgeport; and that it is almost four times as great as the tonnage moved between New York and Hartford, which has a population almost as great as that of Bridgeport.

For cities more distant from New York than Bridgeport, the ratio of the New York tonnage to the total moved from and to the smaller cities decreases rapidly as the distance from the metropolis increases. Thus, while the tonnage between Bridgeport and New York City, Brooklyn and Jersey City is 12 per cent of the total tonnage originating at or destined to Bridgeport, the corresponding ratio for New Haven is less than 3 per cent, and for Hartford less than 2 per cent.

3. The development of motor-truck transportation has been accompanied by distinct changes in methods of distributing goods, especially in the short-haul zones. The fact that a certain amount of tonnage is at the present time transported between two cities by motor truck does not indicate that this same tonnage would, in the absence of the motor truck, be transported by rail. The motor truck has provided a type of transportation service that neither the railroad nor any other carrier limited to fixed lines of movement can render. The smaller towns and villages, even though provided with rail facilities, now obtain a large part of the goods they require for retail distribution by daily motor-truck service from the larger cities. Without the motor truck, a part of these goods would reach the smaller towns by irregular rail shipments in larger quantities, and other types of goods, particularly perishables, would not be regularly provided to the smaller markets.

Motor-truck transportation has thus widened the market for certain types of commodities. By providing regular and rapid transportation service between wholesale distribution points and the smaller retail markets, it has made possible a regular supply of perishable foodstuffs in these markets and thus increased the effective demand for such commodities. It has also enabled the retail dealer to operate with a smaller stock of goods, reducing the amount of capital invested and providing the consumers with fresher goods. These changes in distribution methods are beneficial to the consumer through the reduction of marketing costs and through the provision of a more varied supply of fresh commodities.

A quantitative measure of the effect of these changes in distribution methods is not available and can perhaps never be accurately determined. It is evident, however, that these changes have had an effect upon the tonnage of commodities transported between various towns. Therefore, it may be well to repeat that the fact that an increased tonnage is now being transported by motor truck does not mean that this same tonnage would be transported by rail if motor-truck transportation were not available.

4. The greater part of the tonnage transported by motor truck between the cities compared above is moved in trucks owned and operated by the shipper of the commodity. Only a small part is transported by motor-truck common carriers. The ownership of the vehicle of transportation by the shipper results in a type of service which can not be rendered by other transportation agencies. The service is more flexible both as to location and time. It is usually a complete transportation service instead of a terminal-to-terminal movement, and is adaptable to greater variations in degrees of service. These differences in service tend to reduce the amount of true competition between the two types of transportation.

5. The conditions of transportation by the two methods (rail l. c. l. and motor truck) are very dissimilar. Packing requirements differ, the amount of handling of goods in transit is very different, and the time required for transportation varies considerably.

These factors tend to reduce the amount of tonnage transported by motor truck which is actually competitive with rail transportation. They do not, however, completely eliminate competition between these types of transportation. Competitive business is a small part of motor truck tonnage and perhaps a smaller part of the rail tonnage. The service provided by these two types of transportation is so essentially different in nature that they can not be considered as normally competitive. The motor truck is primarily a facility for small-unit, short-haul transportation, the railroad primarily a facility for large-unit, long-haul transportation. With the stabilization of the motor-trucking industry and the adjustment of the railroad industry to the use of this new type of transportation, the business of the two facilities will be mutually exclusive.

Such losses as the railroads have experienced from the uneconomical competition of the motor trucks, undoubtedly have been more than compensated by the enormous rail tonnage accruing from the manufacture, repair, and delivery of the motor vehicles and their accessories, to say nothing of the propensity to travel which the motor vehicles have stimulated greatly.

Measures which will hasten the stabilization and readjustment of these two transportation facilities are therefore beneficial to both industries. The most valuable of such measures are: (1) The determination of accurate and comprehensive motor-trucking costs in order to define the economic field of motor trucking and prevent an overexpansion of the industry; and (2) regulation of commercial motor trucking to discourage expansion beyond its economic limits, and prevent the establishment of an excessively large number of motor-trucking companies.

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FORECAST OF HIGHWAY TRAFFIC

A KNOWLEDGE of the trend of traffic development on a highway system is a prerequisite to the establishment of an adequate and scientific plan of highway improvement. Although varying in degree of permanency, all highway improvements are expected to provide adequate service. The building of a highway which will not meet traffic demands during the expected life of the improvement is a poor investment resulting in traffic congestion and early reconstruction. On the other hand, the building of a highway with a traffic capacity in excess of the need that may be expected to develop during the life of the improvement is also uneconomic, since it involves an outlay of funds which could more advantageously be used for other highway improvements. A knowledge of future traffic is therefore essential to the establishment of a sound plan of highway improvement.

The most scientific method of future traffic prediction is by projecting past traffic trends. This method has been found accurate in the prediction of population, business conditions, railway traffic, and other economic factors. Accurate prediction on the basis of past trends is possible only when the trend over a considerable period of years is known and also when the period is one of normal development.

No satisfactory series of highway traffic records for the State of Connecticut is available. There are accurate records of traffic over one or two toll bridges, but it is difficult to determine whether or not the trend of traffic at these bridges is indicative of traffic conditions on the entire State highway system.

But while there are no adequate records of traffic development in the State, there are complete records of the motor-vehicle registration for a series of years, and the experience of other States demonstrates that these may be employed as a basis for traffic prediction, since it is found that there is a close and practically constant relation between the rates of growth of registration and traffic. The States in which the relation between the two factors has been determined are Maryland, Maine, and Wisconsin. In each of these States both traffic and registration records are available for a number of years.

In Figure 30 the curves of traffic and motor-vehicle registration in the three States have been brought into proximity by the adjustment of the plotting scales,[19] and to these data have been fitted least-square lines of trend as shown by the dotted lines. These are the straight lines which best represent the trend during the entire period, and it will be seen that the trends of traffic and registration in Maine and Maryland are almost parallel. In Wisconsin the traffic appears to be increasing at a slightly faster rate than the registration, but this divergence is partially explained by the fact that traffic data for 1919 are probably low.[20]

The close agreement between the traffic and registration trends in these States is further indicated in Table 44, which presents the indices of registration and traffic with the average year between 1919 and 1924 as a base.

Table 44.—Indices of registration and traffic in Maine, Maryland, and Wisconsin

[Index of average year between 1919 and 1924=100]

Year	Maine indices		Maryland indices		Wisconsin indices	
	Registration	Traffic	Registration	Traffic	Registration	Traffic
1919	61.8	61.7	59.8	56.6	63.4	53.1
1920	72.7	70.5	73.0	72.2	78.7	78.3
1921	89.6	87.3	85.1	92.0	91.7	84.8
1922	107.0	106.9	103.5	100.5	102.6	101.1
1923	125.5	131.3	128.3	130.3	122.7	129.5
1924	143.4	141.7	150.3	150.0	140.9	153.1

The coincidence of the indices of traffic and registration is unmistakable. Traffic and registration in these widely separated areas have obviously increased at approximately equal rates, despite differences in industrial development, wealth, and population, which have apparently had but slight effect upon the rela-

[19] As the data are plotted on a logarithmic scale, adjustment of plotting points does not affect the data presented.

[20] The Wisconsin Highway Department states that the 1919 traffic average is low in comparison with later years. This was the first year the traffic was observed and not all data were recorded.

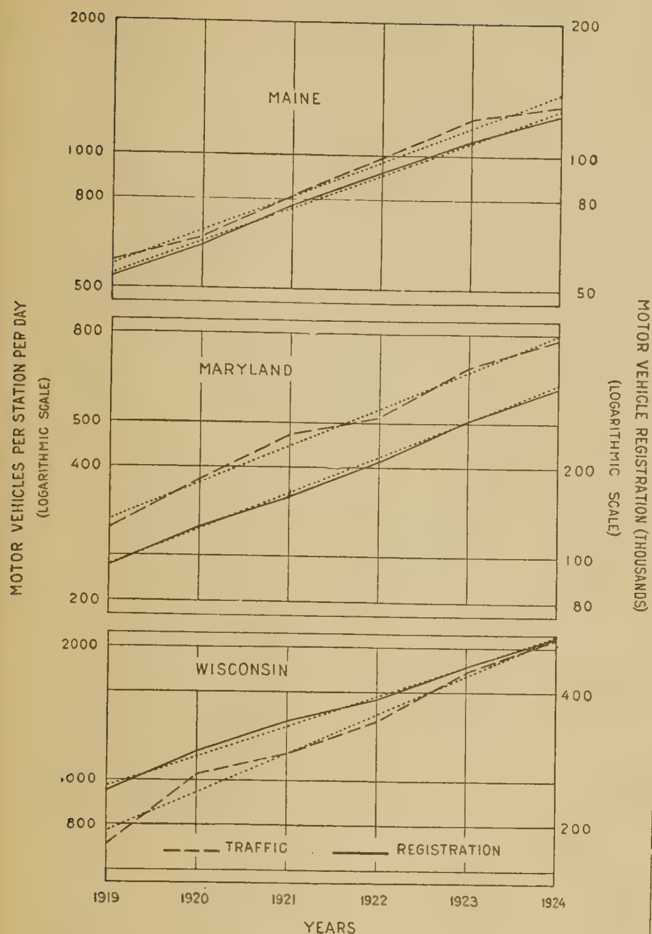

Fig. 30.—Trends of Motor-Vehicle Traffic and Registration in Maine, Maryland, and Wisconsin

tionship. It may therefore be assumed that what is true of these three States, widely separated in location and greatly different in character, will also be true in Connecticut or any other State—namely, that the prediction of motor vehicle registration may be taken as the basis for a prediction of motor vehicle traffic.

It may not be assumed, of course, that the future traffic will be distributed in exactly the same proportions as the present traffic on the various roads. The development of new highways, unusual industrial or resort developments, and suburban expansion will affect the traffic in local areas. For example, the Maryland records indicate that the rate of traffic increase on roads which carried in 1917 more than 300 vehicles a day was slower between that year and 1920 than the increase on roads which at the beginning of the period carried from 100 to 300 vehicles a day. Since 1920, however, the rate of growth has been nearly the same on all highways. But with respect to an entire highway system, all the facts that have been determined indicate that the forecast of expected registration over a short period will give a reasonable measure of the traffic that may be expected.

The estimate of future traffic on the basis of predicted motor-vehicle registration neglects, of course, such factors as the effect of major mechanical improvements to vehicles and assumes, further, that the average mileage per vehicle per year will show no important change over the future period. It would seem, from the nature of the case, however, that any such change would be gradual, and would not be likely to invalidate a prediction made for a period of only five or six years in the future.

Another factor that must be considered is the effect of traffic congestion upon the rate of traffic increase. With respect to the traffic on an entire State highway system, however, the effect of this factor is likely to be negligible, at least during the next few years, although it may operate to reduce somewhat the rate of traffic increase near the large centers of population.

It is finally concluded, therefore, that a prediction of future motor-vehicle traffic may be made upon the basis of a prediction of motor-vehicle registration. The latter can be made upon the basis of records of past years which are available in Connecticut and all other States. In extending into the future the trends of this factor it must be remembered, of course, that vehicle registration is a function of population and that the population is increasing coincidentally with the growing use of motor vehicles. In estimating the future registration from the past registration records it is therefore necessary to take the population factor into account. This can be done by determining the ratio of population to vehicles (persons per car) for the past years, and extending the trend of this ratio into the future. The future registrations over a short period may then be ascertained with some accuracy by dividing the predictable future population by the future values of the persons-per-car ratio, as determined from the past trend of this ratio.

ESTIMATE OF CONNECTICUT HIGHWAY TRAFFIC IN 1930

THAT the method of predicting future traffic from the estimated future motor-vehicle registration may safely be applied in Connecticut is indicated by our knowledge of the close relation existing between the rate of motor-vehicle increase and the growth of traffic over the Saybrook-Lyme Bridge. This is the only point in the State at which traffic records have been consistently made and preserved over a period of years; and these records compared, in Table 45, with the motor-vehicle registration by years since 1916 are remarkably similar to the latter in respect to the rate of increase. If the indices are considered it will be seen that the traffic is alternately higher and lower than the registration, but that in general the two move along together.

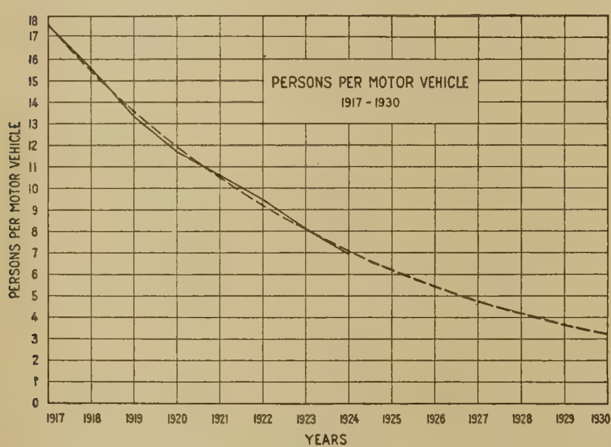

FIG. 31.—NUMBER OF PERSONS PER MOTOR VEHICLE OF RECORD IN CONNECTICUT FROM 1917 TO 1925 AND ESTIMATED FROM 1925 TO 1930

It is assumed, therefore, that the method of prediction found accurate in other States may safely be used in Connecticut. The number of persons per car for each year since 1917 is arrived at by dividing the population by the number of registered motor vehicles. These values are shown in Table 46 and in Figure 31. In the latter there is also shown by the dotted line a smoothed curve which has been fitted, by the method of least squares, to the record of the persons per car for the eight past years. This curve has been projected to 1930 for the purpose of estimating the registrations to that date.

Computing the number of persons per car for each year between 1924 and 1930 from the equation of the curve the values shown in the first column of Table 47 are arrived at, and these divided into the estimated population as shown in column 2 of the same table give the probable registration for each of the years, as shown in the third column.

At the estimated rate of reduction it appears that there will be in Connecticut in 1930, 3.25 persons per car—that is, Connecticut will then have nearly as many cars in relation to its population as California had in 1924. The

Table 45.—Motor-vehicle traffic over Saybrook-Lyme Bridge and Connecticut motor-vehicle registration

Year	Motor vehicle traffic at Saybrook Bridge	Index (1916=100)	Connecticut motor vehicle registration	Index (1916=100)
1916	89, 344	100	56, 048	100
1917	113, 899	128	74, 645	133
1918	124, 235	139	86, 067	154
1919	167, 731	188	102, 410	183
1920	201, 789	226	119, 134	213
1921	232, 797	261	134, 141	239
1922	256, 335	287	152, 977	273
1923	269, 139	301	181, 748	324

Table 46.—Persons per registered motor vehicle in Connecticut, 1917 to 1924

Year	Registration		Estimated population [1]	Persons per vehicle	
	Actual	Estimated		Actual	Estimated
1917	74, 645	74, 640	1, 312, 165	17. 58	17. 58
1918	86, 067	86, 759	1, 339, 552	15. 56	15. 44
1919	102, 410	100, 806	1, 366, 938	13. 35	13. 56
1920	119, 134	117, 072	1, 394, 324	11. 70	11. 91
1921	134, 141	135, 919	1, 421, 710	10. 60	10. 46
1922	152, 977	157, 682	1, 449, 097	9. 47	9. 19
1923	181, 748	182, 959	1, 476, 483	8. 12	8. 07
1924	217, 227	212, 111	1, 503, 869	6. 92	7. 09

[1] Estimates from United States census, Estimates of Population of the United States, 1917 to 1923, and estimates obtained by application of method used by the United States census for following years.

1930 registration is expected to be 182 per cent higher than the 1923 registration. To reach this registration there must be an average annual increase of 16 per cent. As the smallest annual increase between 1917 and 1924 was 12.6 per cent and the largest 19 per cent, this indicated increase for the next five years seems conservative.

Applying the estimated rate of increase to the density of traffic at each of the 1922–23 survey stations, the estimated traffic density in 1930 at each of the stations is determined as shown in Table 48, and as indicated on the map, Figure 32.

Assuming no change in the present State highway system between 1923 and 1930, the traffic upon these highways is expected to be as here shown. The predicted density on the present heavy-traffic routes indicates the pressing need for a comprehensive improvement program during this period.

The Post Road may be expected to carry a daily average of 12,700 vehicles at the New York line, and an average of approximately 9,000 vehicles per day on the section between Greenwich and New Haven; the same route from New Haven to the Massachusetts line may be expected to carry over 6,000 vehicles per day over the greater part of the route.

If the present ratio between average traffic and maximum traffic continues until 1930, approximately two and one-half times the pre-

Table 47.—Estimate of persons per car, population and motor-vehicle registration in Connecticut, 1925 to 1930

Year	Estimated persons per car	Estimated population	Estimated motor vehicle registration
1925	6. 22	1, 531, 250	[1] 246, 000
1926	5. 47	1, 558, 640	285, 000
1927	4. 80	1, 586, 030	330, 000
1928	4. 22	1, 613, 410	382, 000
1929	3. 70	1, 640, 800	443, 000
1930	3. 25	1, 688, 180	513, 000

[1] The actual motor vehicle registration in 1925 was 250,647 vehicles, varying from the estimated registration by less than 2 per cent.

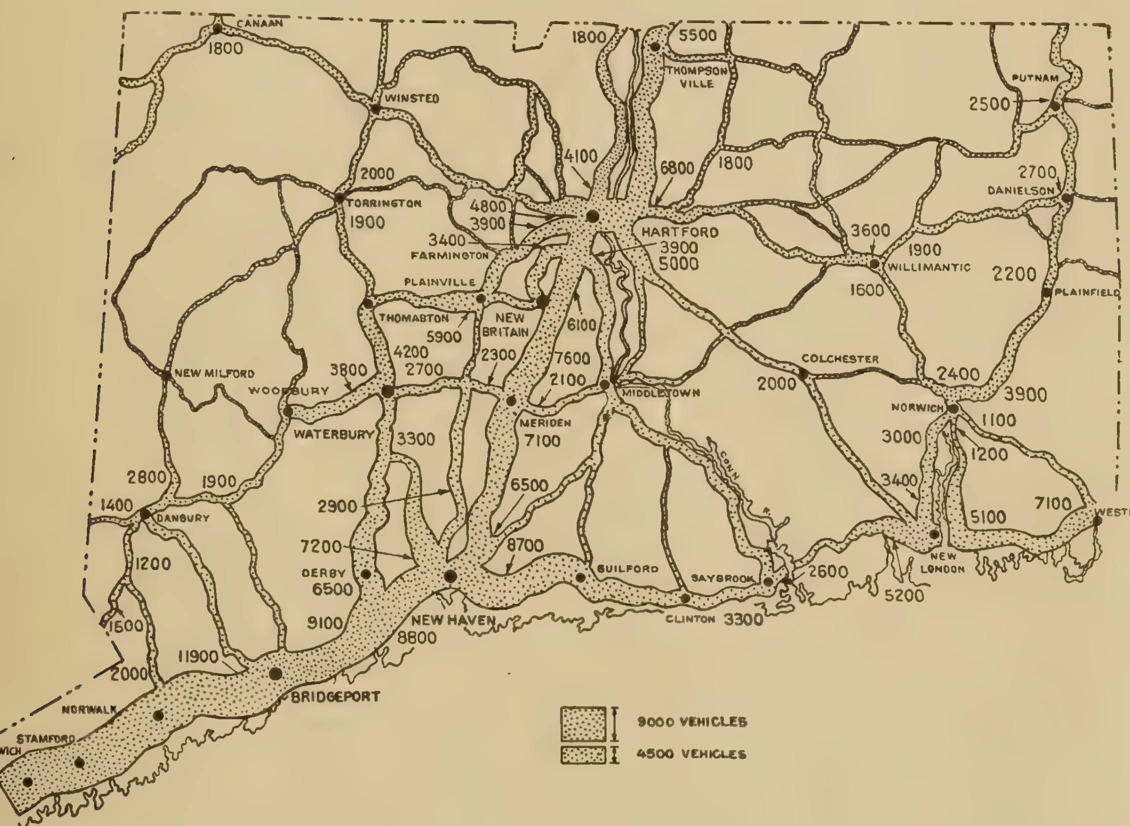

Fig. 32.—Estimated Total Traffic Density on State Highways in 1930

dicted average traffic may be expected to attempt to use these routes on a Sunday during the month of maximum traffic.

The tremendous volume of traffic that may be expected in 1930 on the Post Road and other heavy-traffic routes will require extensive enlargements of the traffic capacity of these routes or the opening of alternate routes in order that adequate highway service may be provided.

Improvements on routes of secondary traffic importance will also be required, particularly routes at present improved with the lower types of surfaces, but the present heavy-traffic routes will continue to be the most important problem in the provision of adequate and economical service to the users of the Connecticut highway system.

Table 48.—Forecast of traffic density at Connecticut survey stations in 1930

Station	Average daily density of traffic	Station	Average daily density of traffic	Station	Average daily density of traffic	Station	Average daily density of traffic
	Total vehicles		*Total vehicles*		*Total vehicles*		*Total vehicles*
1	2, 800	16	3, 300	30	2, 500	44	5, 000
2	1, 400	17	2, 600	31	1, 900	45	6, 800
3	1, 900	18	5, 200	32	1, 600	46	5, 500
4	1, 200	19	7, 100	33	3, 600	47	1, 800
5	1, 500	20	5, 100	34	1, 800	48	4, 100
6	12, 700	21	3, 400	35	6, 100	49	4, 800
7	2, 000	22	3, 000	36	7, 600	50	5, 900
8	11, 900	23	1, 200	37	2, 100	51	2, 000
9	9, 100	24	1, 100	38	7, 100	52	1, 900
10	6, 500	25	2, 000	39	2, 300	53	4, 200
11	8, 800	26	2, 400	40	3, 700	54	2, 700
12	7, 200	27	3, 900	41	3, 900	55	3, 800
13	2, 900	28	2, 200	42	3, 400	56	3, 300
14	6, 500	29	2, 700	43	3, 900	57	1, 800
15	8, 700						

APPENDIX I

TYPES AND LENGTHS OF STATE-AID ROADS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923

1. GROUP A TOWNS (POPULATION, 0 TO 63 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Andover	2.11	0.27			1.84				
Ashford	5.90	.92	3.04		1.94				
Barkhamsted	4.23		4.23						
Bethany	.80	.21				0.59			
Bethlehem	1.29	.27	.02		1.00				
Bolton	.76	.71	.05						
Bozrah	1.99	1.02			.97				
Bridgewater	4.02				4.02				
Brookfield	3.45	.67			2.78				
Brooklyn									
Burlington	.56	.11	.45						
Canaan	1.95	.77	1.18						
Canterbury	3.54	1.16	.85		1.53				
Chaplin									
Colchester	2.10	.74	.55		.81				
Colebrook	6.36	.63	2.28		3.45				
Columbia	1.04	.26			.56	.22			
Cornwall	4.45	4.30	.15						
Coventry	3.97	.22	3.12		.63				
Durham	1.90				.94	.96			
Eastford	2.15	.25	1.90						
East Granby	6.33	.53	.72		1.07	4.01			
East Haddam	3.32				3.32				
Easton	4.86		2.97			1.89			
Ellington	5.12	.19	4.46		.47				
Franklin	3.42	.71	2.55		.16				
Goshen	2.35		.13		2.22				
Granby	3.11		.45		2.66				
Guilford	.43				.43				
Haddam	1.16	.09			1.07				
Hampton	1.57	.12			1.45				
Hartland	1.68	1.68							
Harwinton	5.83	3.43	.15		2.25				
Hebron	7.42	4.17	1.77		1.48				
Kent	.74	.74							
Killingworth	.52	.52							
Lebanon	6.29	1.17	2.36		2.76				
Ledyard	1.99	1.99							
Lisbon	5.15	.11	2.26		2.78				
Litchfield	1.02					1.02			
Lyme	.08	.08							
Madison	6.83	2.86	.92		3.05				
Mansfield	2.42	.15	2.27						
Marlborough									
Middlebury	5.97	2.77	3.20						
Monroe	3.20	.30		2.90					
Morris	6.59	3.11	.08		2.30	1.10			
New Fairfield	3.96	1.51	2.45						
New Hartford	1.57		1.57						
Newtown	2.09			.86	1.23				
Norfolk	7.84	1.66		3.23	2.95				
North Branford									
North Stonington	8.55	3.39	5.16						
Old Lyme	7.60	.07	3.45		1.08	3.00			
Oxford	6.91		2.54		4.37				
Pomfret	3.14				1.02	2.12			
Prospect	3.93	2.56			1.37				
Redding	7.37	2.58	2.05		2.74				
Roxbury	2.33	2.33							
Salem									
Salisbury	1.78	.25	.63		.90				
Scotland	2.97	.09	.90		1.98				
Sharon	5.82	.77	2.66		2.39				
Sherman	.82				.82				
Somers	.61					.61			
Southbury	4.84	.19	4.21		.44				
Sterling	5.29	1.36	2.04		1.89				
Tolland									
Union	1.85	1.31	.54						
Voluntown	5.02	1.33	2.91		.78				
Warren	3.46	3.46							
Washington	5.49	.89	.33		4.27				
Westbrook	3.61	.90		1.97	.74				
Weston	3.95	1.21	.95		1.79				
Willington	.18	.18							
Wilton	7.71	.09	6.10		1.52				
Wolcott	2.68	2.68							
Woodbridge	6.14		.55	2.06	2.74	.79			
Woodbury	2.23	1.25		.50	.48				
Woodstock	7.51		.20		7.31				
Total	267.22	67.29	81.35	11.52	90.75	16.31			

APPENDIX I.—TYPES AND LENGTHS OF STATE-AID ROADS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923—Continued

2. GROUP B TOWNS (POPULATION, 64 TO 127 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Avon	3.47	0.22	2.37		0.88				
Bloomfield	6.76				4.99	1.77			
Canton	1.30	.16	.73		.41				
Cheshire	5.67	.16	3.76		.53			1.22	
Chester	4.24				4.24				
Clinton	3.35				3.35				
East Hampton	4.16	.35	1.07		2.28	.46			
East Lyme	5.45		3.33		.98	1.14			
Glastonbury	4.79				4.79				
Griswold	8.38			3.37	4.17			.84	
Middlefield	7.76		.72		7.04				
Montville	3.50			1.29	2.21				
New Milford	1.86		1.54					.32	
North Canaan	1.50		.15	1.35					
North Haven	6.45				6.07			.38	
Old Saybrook	6.81		1.72	5.09					
Preston	3.70				3.70				
Ridgefield	8.80		1.84		.52	1.10		5.34	
Rocky Hill	5.73			1.32	3.57	.84			
Simsbury	5.96				5.96				
South Windsor	5.86		.34		2.71	2.81			
Stafford									
Suffield	5.79				1.10	2.96	0.34	1.39	
Thompson	6.95	.18	2.35		.96	3.46			
Trumbull	5.89	.48	2.01		3.40				
Waterford	3.79				3.77	.02			
Total	127.92	1.55	21.93	12.42	67.63	14.56	.34	9.49	
3. GROUP C TOWNS (POPULATION, 128 TO 319 PERSONS PER SQUARE MILE)									
Beacon Falls	2.22		2.22						
Berlin	7.61	0.66			4.62	1.37		0.96	
Bethel	2.65	1.45	1.20						
Branford	4.38							4.38	
Cromwell	5.58	.09	3.32		1.04	1.13			
Darien	2.70							2.70	
East Haven	2.07				.77			1.30	
East Windsor	6.03		1.38	1.45	3.20				
Essex	6.44			2.27	2.74	1.43			
Farmington	.38				.38				
Groton	5.50	2.66			2.84				
Hamden	3.72				.07			3.65	
Killingly	2.69	.91			1.30	.48			
New Canaan	9.15				5.14	2.10	1.91		
Newington	9.72				6.86	2.73	.13		
Plainfield	4.57		3.70		.87				
Plymouth	2.53	1.78	.75						
Portland	1.67	.34	.81		.52				
Saybrook	2.99				1.89	1.10			
Shelton	5.60		2.10	1.44	1.84		.22		
Southington	3.13		.32		1.62	1.19			
Sprague	7.01		2.76		4.25				
Stonington	2.37	.13	1.85		.39				
Thomaston	1.68				.79			.89	
Watertown	9.51	1.30	2.33	.66	2.14			3.02	0.06
Westport	2.97		.31		2.12			.54	
Winchester	3.92			1.42	2.50				
Windsor	4.10				.08	3.95		.07	
Total	122.89	9.32	23.05	7.24	47.97	15.48	2.26	17.51	.06
4. GROUP D TOWNS (POPULATION, 320 TO 639 PERSONS PER SQUARE MILE)									
Danbury									
Enfield	1.32				0.21	0.78	0.33		
Fairfield	7.04		2.08		2.77	1.98	.21		
Greenwich	4.66						2.08	2.58	
Middletown	4.17				4.12	.05			
Milford	7.35		1.31		2.40	2.51		1.13	
Orange [1]	11.33		.97		3.73	2.62		4.01	
Plainville									
Putnam	3.14				1.64	1.19	.31		
Seymour	4.72		3.61		.16		.14	.81	
Torrington	4.04		.08	3.96					
Vernon	3.28				3.28				
Wallingford	3.13				2.06	1.07			
West Hartford	4.27				1.55	.02	.21	2.49	
Wethersfield	8.91	0.25			3.95	4.71			
Windham	2.57		2.57						
Windsor Locks	4.00				2.45	1.41		.14	
Total	73.93	.25	10.62	3.96	28.32	16.34	3.28	11.16	

[1] West Haven included with Orange.

APPENDIX I.—TYPES AND LENGTHS OF STATE-AID ROADS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923—Continued

5. GROUP E TOWNS (POPULATION, 640 TO 1,279 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Bristol	4.41		2.63		1.41		0.15	0.22	
East Hartford	5.26				4.40	0.86			
Manchester	3.70				1.79	.63		1.28	
Naugatuck	1.85	0.11	.85		.25	.64			
Norwalk	4.24			1.66				2.58	
Norwich	5.94		.33		5.61				
Stamford	15.62		1.11		14.51				
Stratford	3.47	.82			1.27			1.38	
Total	44.49	.93	4.92	1.66	29.24	2.13	.15	5.46	

6. GROUP F TOWNS (POPULATION, 1,280 TO 6,399 PERSONS PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Ansonia	3.10				1.81		0.57		0.72
Derby	1.49				.08		1.09	0.32	
Meriden	3.94		0.14		1.41	1.20		1.19	
New Britain	4.96				4.96				
New London	5.00				4.20	.80			
Waterbury	3.84	0.94	.41				.94	1.55	
Total	22.33	.94	.55		12.46	2.00	2.60	3.06	.72

7 GROUP G TOWNS (POPULATION, 6,400 PERSONS AND MORE PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Bridgeport	2.52				2.31		0.21		
Hartford	1.67				1.50			0.17	
New Haven	3.56				2.00	0.36	.10	1.10	
Total	7.75				5.81	.36	.31	1.27	

8. RECAPITULATION (ALL POPULATION GROUPS)

Group	Population per square mile	Mileage of various types								
		Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
A	0–63	267.22	67.29	81.35	11.52	90.75	16.31			
B	64–127	127.92	1.55	21.93	12.42	67.63	14.56	0.34	9.49	
C	128–319	122.89	9.32	23.05	7.24	47.97	15.48	2.26	17.51	0.06
D	320–639	73.93	.25	10.62	3.96	28.32	16.34	3.28	11.16	
E	640–1,279	44.49	.93	4.92	1.66	29.24	2.13	.15	5.46	
F	1,280–6,399	22.33	.94	.55		12.46	2.00	2.60	3.06	.72
G	6,400 and more	7.75				5.81	.36	.31	1.27	
All towns		666.53	80.28	142.42	36.80	282.18	67.18	8.94	47.95	.78

APPENDIX II

TYPES AND LENGTHS OF TRUNK-LINE HIGHWAYS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923

1. GROUP A TOWNS (POPULATION, 0 TO 63 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Andover	5.24		5.24						
Ashford	1.40	1.40							
Barkhamsted	6.18	5.43	.75						
Bethany	5.67		1.37		4.30				
Bethlehem	4.94	.71			4.23				
Bolton	5.65	1.03	.90	1.28	1.61	0.83			
Bozrah	4.14	2.72				1.42			
Bridgewater	4.01				4.01				
Brookfield	5.45	2.00	3.45						
Brooklyn	10.86	.49			7.00	3.37			
Burlington	2.44	1.50			.94				
Canaan	6.49		6.49						
Canterbury	.13		.13						
Chaplin	8.87	2.23	6.64						
Colchester	10.87		3.37	.34				7.16	
Colebrook	6.87		1.42		5.45				
Columbia	9.25	1.68	3.46		1.92	2.19			
Cornwall	10.60	8.94	1.06		.60				
Coventry	2.91		.79		2.12				
Durham	8.90				8.90				
Eastford	5.81		3.62		2.19				
East Granby	3.25		.97		2.28				
East Haddam	4.05				4.05				
Easton	5.83		2.13			3.70			
Ellington	6.77	.86	5.91						
Franklin	7.38		3.95		3.43				
Goshen	8.63				8.63				
Granby	10.38	.81			6.21	3.36			
Guilford	17.63				15.87	1.67			0.09
Haddam	14.97			9.14	5.83				
Hampton	4.73	1.99	.44		.96	1.34			
Hartland	6.96	5.39			1.57				
Harwinton	3.91							3.91	
Hebron	2.54	.41	.25		.18			1.70	
Kent	4.70	1.34	3.36						
Killingworth	6.41	1.70		2.18	2.53				
Lebanon	3.30		3.30						
Ledyard	7.20				5.55	1.65			
Lisbon	5.18		5.03		.15				
Litchfield	15.35	2.45	.97		9.69		.24	2.00	
Lyme	4.12				4.12				
Madison	6.03				5.78	.09		.16	
Mansfield	17.49	2.19	13.34		1.96				
Marlborough	7.82	.06			1.48			6.28	
Middlebury	4.67	1.83	2.84						
Monroe	4.49			4.30	.19				
Morris	1.56				.45	1.11			
New Fairfield	2.22	1.78	.44						
New Hartford	5.93	.25	2.14	.63	2.91				
Newtown	11.70		6.49		5.21				
Norfolk	5.94	1.38		2.30	2.26				
North Branford	8.52				8.52				
North Stonington	9.15		.07			9.08			
Old Lyme	8.23		4.64		3.59				
Oxford	.32	.32							
Pomfret	8.81				8.81				
Prospect									
Redding	5.64		.65			4.99			
Roxbury	5.46	2.18			3.28				
Salem	6.46							6.46	
Salisbury	11.29	.63	7.93			.70		2.03	
Scotland									
Sharon	5.32		4.88		.44				
Sherman	3.11	1.02		1.29	.80				
Somers	9.89	5.44			1.07	3.36		.02	
Southbury	6.84	.66	3.98		2.20				
Sterling	3.49		3.49						
Tolland	7.32	2.51	2.82		1.99				
Union									
Voluntown									
Warren									
Washington	6.49				6.49				
Westbrook	4.01			1.72	2.29				
Weston									
Willington	10.62	5.08	2.45	2.46	.63				
Wilton	7.81		7.81						
Wolcott	1.04	.24	.03					.77	
Woodbridge	3.97			.63	3.34				
Woodbury	10.94	5.02	3.33	1.04	.33	1.22			
Woodstock	5.41		1.01		4.40				
Total	487.96	73.67	133.34	27.31	182.74	40.08	.24	30.49	.09

APPENDIX II.—TYPES AND LENGTHS OF TRUNK-LINE HIGHWAYS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923—Continued

2. GROUP B TOWNS (POPULATION, 64 TO 127 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Avon	8.32				8.32				
Bloomfield	9.93				9.65	0.28			
Canton	6.85		3.35	1.25	2.25				
Cheshire	6.56				.22		0.65	5.69	
Chester	2.76				2.76				
Clinton	6.87			3.03	3.51			.33	
East Hampton	6.63	3.15			3.48				
East Lyme	4.86				1.86	3.00			
Glastonbury	10.01				2.58	1.23	1.13	5.07	
Griswold	2.85		1.82		1.03				
Middlefield	3.48				3.48				
Montville	7.99				4.96			3.03	
New Milford	12.47	.34		2.88	9.25				
North Canaan	8.70	.01	4.28	2.68	1.20			.53	
North Haven	10.77				3.61		7.14	.02	
Old Saybrook	8.26		.46		7.80				
Preston	6.74				4.21	2.53			
Ridgefield	10.69	.74	6.50		3.45				
Rocky Hill	3.42				3.19			.23	
Simsbury	10.09			.51	7.88	.35	1.35		
South Windsor	5.09						5.09		
Stafford	10.41		1.82	.88	2.69	5.02			
Suffield	5.07				2.83			2.24	
Thompson	11.52		3.73		1.83	4.89	.69	.38	
Trumbull	5.25					5.25			
Waterford	12.75		.18		3.46	1.82		7.29	
Total	198.34	4.24	22.14	11.23	95.50	24.37	16.05	24.81	

3. GROUP C TOWNS (POPULATION, 128 TO 319 PERSONS PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Beacon Falls	4.78						2.78	2.00	
Berlin	5.48						.83	4.65	
Bethel	7.04				2.43	2.51		2.10	
Branford	7.03			0.99	2.30	2.08	.37	1.29	
Canaan									
Cromwell	4.57				3.05	.80	.72		
Darien	3.90					1.18	2.57	.12	0.03
East Haven	3.86				2.20	.40		1.26	
East Windsor	4.79					.55	4.21		.03
Essex	3.33				3.33				
Farmington	13.18				4.36	3.43	4.21	1.18	
Groton	10.27				6.09			4.18	
Hamden	9.97	0.62			2.69		1.48	5.18	
Killingly	17.27		5.16		6.47	4.63	.36	.65	
Newington	3.55							3.55	
Plainfield	14.10		5.94		7.86			.30	
Plymouth	4.30				2.65		1.02	.60	.03
Portland	10.13	2.52	.29		4.94		2.38		
Saybrook	2.60				2.60				
Shelton	4.94		3.66	.36	.35		.57		
Southington	11.83			2.77	3.38		3.74	1.94	
Sprague									
Stonington	12.17		.01		2.43	2.77		6.96	
Thomaston	8.46		.75	.45	3.53		.03	3.66	.04
Watertown									
Westport	4.67						4.23	.30	.14
Winchester	10.78		1.28		8.30	1.03	.17		
Windsor	7.73				2.39		1.34	3.87	.13
Total	190.73	3.14	17.09	4.57	71.35	19.38	31.01	43.79	.40

4. GROUP D TOWNS (POPULATION, 320 TO 639 PERSONS PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Danbury	15.29	1.43	9.15		3.94			0.77	
Enfield	11.66				5.00	0.96	3.93	1.76	0.01
Fairfield	9.33		4.45	0.26	.86		3.76		
Greenwich	4.56						3.81	.65	.10
Middletown	11.19			2.22	4.52		2.22	2.23	
Milford	6.09				.03	2.33	.21	3.52	
Orange [1]	10.34					.42		9.92	
Plainville	6.69				4.76		1.93		
Putnam	11.01	.03	4.69		5.29		.25	.75	
Seymour	4.65		.55				3.96	.12	.02
Torrington	13.20	1.86	.25	.15	7.43	.55		2.96	
Vernon	5.19				4.69	.50			
Wallingford	6.32		.06				5.15	1.11	
West Hartford	12.39				4.38	1.53	5.09	1.39	
Wethersfield	5.37					3.03		2.34	
Windham	12.57	.70	9.63		1.60			.64	
Windsor Locks	2.97				2.17	.04		.76	
Total	148.82	4.02	28.78	2.63	44.67	9.36	30.31	28.92	.13

[1] West Haven included with Orange.

APPENDIX II.—TYPES AND LENGTHS OF TRUNK-LINE HIGHWAYS BY TOWNS IN THE SEVERAL POPULATION GROUPS, JULY 1, 1923—Continued

5. GROUP E TOWNS (POPULATION, 640 TO 1,279 PERSONS PER SQUARE MILE)

Town	Mileage of various types								
	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Bristol	5.62		1.35		0.40		2.99	0.86	0.02
East Hartford	8.88						8.00	.85	.03
Manchester	8.84		1.61		5.09		1.04	1.10	
Naugatuck	6.54	0.37	2.70		.33		3.13	.01	
Norwalk	6.51		1.29				1.36	3.75	.11
Norwich	7.59	.65			6.05	0.35		.54	
Stamford	1.41						1.30	.11	
Stratford	7.83		4.17				2.36	1.30	
Total	53.22	1.02	11.12		11.87	.35	20.18	8.52	.16

6. GROUP F TOWNS (POPULATION, 1,280 TO 6,399 PERSONS PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Ansonia	1.53						1.53		
Derby	4.65		1.00		0.48		1.14	2.03	
Meriden	6.79				3.69		3.04	.02	0.04
New Britain	3.79				.60		.69	2.50	
New London	2.48							2.48	
Waterbury	6.03		1.28		.54		.95	3.26	
Total	25.27		2.28		5.31		7.35	10.29	.04

7. GROUP G TOWNS (POPULATION, 6,400 PERSONS AND MORE PER SQUARE MILE)

Town	Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
Bridgeport	2.58						2.58		
Hartford	2.96						.67	2.20	0.09
New Haven	4.16					0.60	2.79	.77	
Total	9.70					.60	6.04	2.97	.09

8. RECAPITULATION (ALL POPULATION GROUPS)

Group	Population per square mile	Mileage of various types								
		Total	Graded	Gravel	Stone surface	Water-bound macadam	Bituminous macadam	Bituminous concrete	Concrete	Brick, wood block, and granite block
A	0–63	487.96	73.67	133.34	27.31	182.74	40.08	0.24	30.49	0.09
B	64–127	198.34	4.24	22.14	11.23	95.50	24.37	16.05	24.81	
C	128–319	190.73	3.14	17.09	4.57	71.35	19.38	31.01	43.79	.40
D	320–639	148.82	4.02	28.78	2.63	44.67	9.36	30.31	28.92	.13
E	640–1,279	53.22	1.02	11.12		11.87	.35	20.18	8.52	.16
F	1,280–6,399	25.27		2.28		5.31		7.35	10.29	.04
G	6,400 and more	9.70					.60	6.04	2.97	.09
All towns		1,114.04	86.09	214.75	45.74	411.44	94.14	111.18	149.79	.91

APPENDIX III

ANALYSIS OF DETAILS OF DISBURSEMENTS BY APPROPRIATION ON CONNECTICUT STATE HIGHWAYS FROM 1895 TO JULY 1, 1923

(Data from 1923 report, State highway department, item 2, and other State highway department records)

Years	Total	State-aid roads						Trunk-line roads						Bridges		Administration, engineering, and supervision	
		Total	Per cent [1]	Construction	Per cent [2]	Repairs	Per cent [2]	Total	Per cent [1]	Construction [3]	Per cent [4]	Repairs	Per cent [4]	Total	Per cent [1]	Total	Per cent [1]
1895	$1, 984															$1, 984	100. 0
1896	43, 546	$30, 643	70. 4	$30, 643	100. 0											12, 903	29. 6
1897	122, 343	112, 374	91. 9	112, 374	100. 0											9, 969	8. 1
1898	78, 722	72, 943	92. 7	72, 943	100. 0											5, 779	7. 3
1899	117, 974	111, 869	94. 8	111, 869	100. 0											6, 104	5. 2
1900	99, 159	89, 577	90. 3	89, 577	100. 0											9, 583	9. 7
1901	183, 924	170, 160	92. 5	170, 160	100. 0											13, 767	7. 5
1902	129, 429	117, 854	91. 1	117, 854	100. 0											11, 575	8. 9
1903	202, 809	185, 140	91. 3	185, 140	100. 0											17, 669	8. 7
1904	181, 589	162, 781	89. 6	162, 781	100. 0											18, 808	10. 4
1905	250, 404	233, 016	93. 1	233, 016	100. 0											17, 388	6. 9
1906	167, 886	136, 675	81. 4	136, 675	100. 0			$6, 152	3. 7	$6, 152	100. 0					25, 058	14. 9
1907	272, 892	242, 666	88. 9	242, 666	100. 0											30, 226	11. 1
1908	346, 470	290, 078	83. 7	272, 598	94. 0	$17, 480	6. 0	17, 471	5. 0	17, 471	100. 0					38, 920	11. 3
1909	863, 524	551, 478	63. 9	513, 064	93. 0	38, 414	7. 0	258, 162	29. 9	258, 162	100. 0					53, 883	6. 2
1910	1, 200, 946	563, 285	46. 9	417, 216	74. 1	146, 069	25. 9	569, 816	47. 4	569, 816	100. 0					67, 844	5. 7
1911	1, 585, 730	892, 493	56. 3	536, 813	60. 1	355, 680	39. 9	598, 515	37. 7	598, 515	100. 0					94, 721	6. 0
1912	1, 453, 512	444, 111	30. 6	337, 456	76. 0	106, 655	24. 0	930, 502	64. 0	263, 661	28. 3	$666, 841	71. 7			78, 897	5. 4
Total, 1895–1912	7, 302, 842	4, 407, 143	60. 3	3, 742, 845	84. 9	664, 298	15. 1	2, 380, 618	32. 6	1, 713, 777	72. 0	666, 841	28. 0			515, 078	7. 1
1913	3, 483, 575	968, 301	27. 9	754, 436	77. 9	213, 865	22. 1	2, 371, 153	68. 0	1, 401, 231	59. 1	969, 922	40. 9			144, 121	4. 1
1914	3, 423, 218	1, 431, 124	41. 8	1, 318, 091	92. 1	113, 033	7. 9	1, 803, 315	52. 7	1, 001, 371	55. 5	801, 944	44. 5			188, 779	5. 5
1915	2, 235, 361	777, 996	34. 8	620, 092	79. 7	157, 904	20. 3	1, 293, 412	57. 9	361, 098	27. 9	932, 314	72. 1	$1, 299		162, 652	7. 3
1916	1, 950, 948	366, 380	18. 8	196, 020	53. 5	170, 360	46. 5	1, 271, 774	65. 2	188, 961	14. 8	1, 082, 813	85. 2	143, 104	7. 3	169, 690	8. 7
1917	2, 528, 222	294, 983	11. 7	108, 529	36. 8	186, 454	63. 2	1, 759, 244	69. 6	150, 189	8. 5	1, 609, 055	91. 5	298, 277	11. 8	175, 717	6. 9
1918	3, 569, 306	435, 177	12. 2	240, 505	55. 3	194, 672	44. 7	2, 556, 387	71. 6	601, 770	23. 5	1, 954, 617	76. 5	384, 466	10. 8	193, 277	5. 4
1919	2, 385, 934	257, 410	10. 7	67, 031	26. 0	190. 379	74. 0	1, 556, 020	65. 3	368, 721	23. 7	1, 187, 299	76. 3	407, 321	17. 1	165, 184	6. 9
1920	5, 634, 366	886, 367	15. 7	610, 898	68. 9	275, 469	31. 1	3, 486, 810	61. 9	1, 286, 625	36. 9	2, 200. 185	63. 1	965, 806	17. 2	295. 383	5. 2
1921	7, 127, 961	815, 044	11. 4	431, 745	53. 0	383, 299	47. 0	5, 110, 147	71. 7	2, 908, 675	56. 9	2, 201, 472	43. 1	892, 265	12. 5	310, 505	4. 4
1922	5, 997, 849	805, 897	13. 4	533, 125	66. 2	272, 772	33. 8	4, 269, 592	71. 2	2, 594, 276	60. 8	1, 675, 316	39. 2	606, 803	10. 1	315, 558	5. 3
1923	6, 912, 856	594, 522	8. 6	313, 571	52. 7	280, 951	47. 3	5, 663, 320	81. 9	3, 451, 973	61. 0	2, 211, 347	39. 0	326, 041	4. 7	328, 974	4. 8
Total, 1913–1923	45, 249, 597	7, 633, 201	16. 9	5. 194, 043	68. 0	2, 439, 158	32. 0	31, 141, 174	68. 8	14, 314, 890	46. 0	16, 826, 284	54. 0	4, 025, 382	8. 9	2, 449, 840	5. 4
Total, 1895–1923	52,552,439	12, 040, 344	22. 9	8 936, 888	17. 0	3, 103, 456	5. 9	33, 521, 792	63. 8	16, 028, 667	47. 8	17, 493, 125	52. 2	4, 025, 382	7. 7	2, 964, 918	5. 6

[1] Percentage of total expenditures for the period.
[2] Percentage of total expenditures for the period on State-aid roads.
[3] "Construction" includes contract and repair reconstruction items.
[4] Percentage of total expenditure for the period on trunk-line highways.

APPENDIX IV

REVENUE RECEIPTS OF CONNECTICUT BY FISCAL YEARS FOR THE 10-YEAR PERIOD ENDED JUNE 30, 1923

(Data from comparative financial statement; State Register and Manual, 1924; trust funds not included)

Fiscal year	Total	Railroads and street railways [1]	Per cent	Insurance corporations and companies [2]	Per cent	Other corporations [3]	Per cent	Inheritance tax [4]	Per cent	Town tax [5]	Per cent	Highway refunds and receipts [6]	Per cent	Motor vehicles						All other receipts	Per cent
														Total	Per cent	Fees and fines [7]	Per cent	Gas tax [8]	Per cent		
1914	$6,825,809	$1,580,592	23.2	$644,767	9.4	$909,394	13.3	$669,674	9.8	$1,101,332	16.2	$330,418	4.8	$406,623	6.0	$406,623	6.0			$1,183,009	17.3
1915	6,972,100	1,091,290	15.7	685,269	9.8	922,434	13.2	807,293	11.6	1,173,710	16.8	398,439	5.8	536,970	7.7	536,970	7.7			1,356,695	19.4
1916	11,532,807	1,347,306	11.7	1,327,708	11.5	2,783,870	24.1	1,310,764	11.4	1,750,974	15.2	249,086	2.1	768,728	6.7	768,728	6.7			1,994,371	17.3
1917	15,387,000	2,433,992	15.8	1,563,555	10.2	4,758,487	30.9	1,050,988	6.8	1,749,026	11.4	400,360	2.6	1,080,589	7.0	1,080,589	7.0			2,350,003	15.3
1918	15,189,327	1,370,340	9.1	1,474,833	9.7	4,219,089	27.7	1,527,165	10.1	1,750,000	11.5	459,494	3.0	1,285,164	8.5	1,285,164	8.5			3,103,242	20.4
1919	[9] 8,014,483	1,481	.2	824,805	10.3	497,341	6.2	850,873	10.6	1,750,000	21.8	477,640	5.9	1,361,898	17.0	1,361,898	17.0			2,250,445	28.0
1920	15,090,168	1,533,457	10.2	1,326,372	8.8	3,270,650	21.7	1,987,767	13.2	1,750,000	11.6	726,903	4.8	1,816,810	12.0	1,816,810	12.0			2,678,209	17.7
1921	17,248,835	1,626,471	9.4	1,257,745	7.3	4,597,125	26.6	1,855,856	10.8	1,750,000	10.2	1,333,456	7.7	2,126,773	12.3	2,126,773	12.3			2,701,409	15.7
1922	20,794,735	1,873,309	9.0	1,189,083	5.7	3,778,989	18.2	2,327,809	11.2	2,000,000	9.6	1,733,593	8.3	3,852,151	18.6	3,409,048	16.4	$443,103	2.2	4,039,801	19.4
1923	22,220,278	2,574,199	11.6	1,273,621	5.7	2,719,528	12.2	2,573,704	11.5	2,000,000	9.1	1,504,805	6.8	4,993,706	22.5	4,227,767	19.0	765,939	3.5	4,580,715	20.6
Total	139,275,542	15,432,437	11.1	11,567,758	8.3	28,456,907	20.4	14,961,893	10.7	16,775,042	12.1	7,614,194	5.5	18,229,412	13.1	17,020,370	12.2	1,209,042	.9	26,237,899	18.8

[1] State Register and Manual for 1924, pp. 362 and 363, items Nos. 27, 28, and 29.
[2] Ibid., items Nos. 12, 22, 23, and 26.
[3] Ibid., items Nos. 4, 25, 26, 30, and 40.
[4] Ibid., item No. 11.
[5] Ibid., item No. 35.
[6] Ibid., items Nos. 8, 9, and 10.
[7] Ibid., items Nos. 20 and 21.
[8] Ibid., item No. 7.
[9] Nine months only.

EXPENDITURES OF CONNECTICUT BY FISCAL YEARS FOR THE 10-YEAR PERIOD ENDED JUNE 30, 1923

[Data from State and State highway department records]

Fiscal year	Total	Legislative and executive	Per cent	Judicial	Per cent	Penal and reformatory	Per cent	Educational	Per cent	Charitable and humane	Per cent	Agriculture	Per cent	Highways and bridges	Per cent	Motor-vehicle department	Per cent	Interest on State bonds	Per cent	All other expenditures	Per cent
1914	$9,293,412	$428,332	4.6	$669,669	7.2	$438,777	4.7	$1,150,431	12.3	$1,532,147	16.5	$242,083	2.6	$3,423,218	36.8			$409,957	4.4	$998,798	10.9
1915	7,930,830	294,606	3.7	662,000	8.3	422,039	5.4	1,253,079	15.8	1,171,544	14.8	203,985	2.6	2,235,361	28.2			471,827	5.9	1,216,389	15.3
1916	7,875,945	153,344	1.9	664,923	8.4	439,267	5.6	1,215,634	15.4	1,428,537	18.1	215,980	2.7	1,950,948	24.8			505,184	6.4	1,302,128	16.5
1917	9,747,176	326,130	3.4	703,566	7.2	504,519	5.2	1,327,933	13.6	1,690,877	17.4	264,300	2.7	2,528,222	25.9	$21,109	0.2	498,055	5.1	1,882,465	19.3
1918	12,603,034	97,388	.8	737,167	5.8	649,461	5.2	1,439,345	11.4	2,956,072	23.5	399,503	3.2	3,569,306	28.3	180,680	1.4	488,740	3.9	2,085,372	16.5
1919	10,179,605	271,758	2.7	599,681	5.9	690,377	6.8	1,415,785	13.9	2,214,371	21.8	315,791	3.1	2,385,934	23.4	125,090	1.2	360,862	3.5	1,799,956	17.7
1920	[1] 19,374,857	115,517	.6	873,472	4.5	815,364	4.2	2,353,251	12.1	3,870,639	20.0	722,618	3.7	5,634,366	29.1	261,961	1.4	478,005	2.5	[1] 4,249,664	[1] 21.9
1921	19,288,022	370,294	1.9	924,276	4.8	879,102	4.6	2,367,237	12.3	4,090,178	21.2	778,822	4.0	7,127,961	37.0	342,632	1.8	461,805	2.3	1,945,715	10.1
1922	20,437,811	162,977	.8	945,689	4.6	1,051,666	5.1	2,699,096	13.2	4,699,549	23.0	891,385	4.4	5,997,849	29.4	299,594	1.5	618,290	3.0	3,071,716	15.0
1923	21,203,978	367,811	1.7	910,005	4.3	983,467	4.6	3,026,827	14.3	4,703,850	22.2	680,167	3.2	6,912,856	32.6	265,108	1.3	656,865	3.1	2,697,022	12.7
Total	137,934,670	2,588,157	1.9	7,690,448	5.6	6,874,039	5.0	18,248,618	13.2	28,357,764	20.6	4,714,634	3.4	41,766,021	30.3	1,496,174	1.1	4,949,590	3.5	21,249,225	15.4

[1] Includes $2,278,815 invested in United States bonds for soldier-relief fund.

APPENDIX V

POPULATION OF CONNECTICUT TOWNS [1]

[Grouped on basis of number of persons per square mile of land area]

Town	Area in square miles	Persons per square mile	Groups by number of persons per square mile: A	B	C	D	E	F	G
			0 to 63	64 to 12	128 to 319	320 to 639	640 to 1,279	1,280 to 6,399	6,400 and more
Andover	15. 8	25	389						
Ansonia	5. 7	3, 095						17, 643	
Ashford	39. 4	17	673						
Avon	20. 3	76		1, 534					
Barkhamsted	38. 2	19	719						
Beacon Falls	8. 9	179			1, 593				
Berlin	23. 5	183			4, 298				
Bethany	19. 5	21	411						
Bethel	15. 2	211			3, 201				
Bethlehem	19. 3	28	536						
Bloomfield	26. 6	90		2, 394					
Bolton	14. 7	31	448						
Bozrah	18. 8	46	858						
Branford	23. 3	284			6, 627				
Bridgeport	18. 0	7, 975							143, 555
Bridgewater	15. 5	31	481						
Bristol	26. 4	781					20, 620		
Brookfield	19. 5	46	896						
Brooklyn	27. 2	61	1, 655						
Burlington	30. 8	36	1, 109						
Canaan	40. 8	14	561						
Canterbury	41. 3	22	896						
Canton	30. 2	84		2, 549					
Chaplin	20. 3	19	385						
Cheshire	29. 6	96		2, 855					
Chester	15. 3	110		1, 675					
Clinton	15. 6	78		1, 217					
Colchester	50. 0	41	2, 050						
Colebrook	31. 9	15	492						
Columbia	21. 9	32	706						
Cornwall	48. 4	17	834						
Coventry	35. 1	45	1, 582						
Cromwell	12. 5	196			2, 454				
Danbury	44. 4	503				22, 325			
Darien	14. 6	287			4, 184				
Derby	5. 0	2, 248						11, 238	
Durham	22. 8	42	959						
Eastford	27. 0	18	496						
East Granby	17. 3	61	1, 056						
East Haddam	52. 8	44	2, 312						
East Hampton	34. 2	70		2, 394					
East Hartford	17. 8	654					11, 648		
East Haven	12. 4	284			3, 520				
East Lyme	34. 4	67		2, 291					
Easton	24. 9	41	1, 017						
East Windsor	26. 1	143			3, 741				
Ellington	34. 4	62	2, 127						
Enfield	34. 6	339				11, 719			
Essex	11. 2	251			2, 815				
Fairfield	31. 5	364				11, 475			
Farmington	24. 0	160			3, 844				
Franklin	18. 4	30	552						
Glastonbury	53. 6	104		5, 592					
Goshen	40. 4	17	675						
Granby	39. 9	34	1, 342						
Greenwich	42. 3	523				22, 123			
Griswold	34. 6	122		4, 220					
Groton	32. 7	282			9, 227				
Guilford	46. 2	61	2, 803						
Haddam	43. 5	40	1, 736						
Hamden	32. 2	267			8, 611				
Hampton	23. 7	20	475						
Hartford	17. 0	8, 120							138, 036
Hartland	34. 0	13	448						
Harwinton	31. 9	63	2, 020						
Hebron	34. 1	27	915						
Kent	48. 0	23	1, 086						
Killingly	49. 0	167			8, 178				
Killingworth	35. 2	15	531						
Lebanon	49. 5	27	1, 343						
Ledyard	38. 0	31	1, 161						
Lisbon	16. 1	54	867						
Litchfield	50. 3	63	3, 180						
Lyme	34. 5	20	674						
Madison	39. 7	47	1, 857						
Manchester	26 5	693					18, 370		
Mansfield	44. 6	58	2, 574						
Marlborough	22. 5	13	303						
Meriden	16. 0	2, 173						34, 764	
Middlebury	19. 1	56	1, 067						
Middlefield	12. 4	84		1, 047					
Middletown	40. 4	548				22, 129			
Milford	24. 9	409				10, 193			
Monroe	26. 3	44	1, 161						
Montville	40. 7	84		3, 411					

[1] Population figures from United States census, 1920.

APPENDIX V.—POPULATION OF CONNECTICUT TOWNS—Continued

Town	Area in square miles	Persons per square mile	Groups by number of persons per square mile						
			A	B	C	D	E	F	G
			0 to 63	64 to 127	128 to 319	320 to 639	640 to 1,279	1,280 to 6,399	6,400 and more
Morris	15.9	31	499						
Naugatuck	16.5	912					15,051		
New Britain	13.4	4,426						59,316	
New Canaan	22.7	171			3,895				
New Fairfield	22.3	21	468						
New Hartford	36.7	49	1,781						
New Haven	21.8	7,456							162,537
Newington	13.4	177			2,381				
New London	5.1	5,037						25,688	
New Milford	61.4	78		4,781					
Newtown	59.1	47	2,751						
Norfolk	44.2	28	1,229						
North Branford	25.3	44	1,110						
North Canaan	19.0	102		1,933					
North Haven	21.3	92		1,968					
North Stonington	53.2	21	1,144						
Norwalk	24.1	1,151					27,743		
Norwich	27.4	1,083					29,685		
Old Lyme	24.7	38	946						
Old Saybrook	17.1	86		1,463					
Orange	28.2	589				16,614			
Oxford	35.3	28	998						
Plainfield	40.1	198			7,926				
Plainville	9.2	447				4,114			
Plymouth	20.9	284			5,942				
Pomfret	40.3	36	1,454						
Portland	25.6	142			3,644				
Preston	29.8	92		2,743					
Prospect	13.4	20	266						
Putnam	18.7	449				8,397			
Redding	31.4	42	1,315						
Ridgefield	34.3	79		2,707					
Rocky Hill	13.9	117		1,633					
Roxbury	26.7	24	647						
Salem	27.2	15	424						
Salisbury	59.0	42	2,497						
Saybrook	14.0	166			2,325				
Scotland	17.8	22	391						
Seymour	14.6	465				6,781			
Sharon	59.1	27	1,585						
Shelton	30.5	311			9,475				
Sherman	23.0	23	533						
Simsbury	29.8	99		2,958					
Somers	29.1	57	1,673						
Southbury	39.5	28	1,093						
Southington	37.1	227			8,440				
South Windsor	28.3	76		2,142					
Sprague	12.6	198			2,500				
Stafford	58.3	93		5,407					
Stamford	37.4	1,071					40,067		
Sterling	25.9	49	1,266						
Stonington	36.9	277			10,236				
Stratford	18.9	653					12,347		
Suffield	41.7	98		4,070					
Thomaston	13.1	305			3,993				
Thompson	46.1	110		5,055					
Tolland	37.0	28	1,040						
Torrington	37.4	589				22,055			
Trumbull	23.3	111		2,597					
Union	28.2	9	257						
Vernon	17.8	500				8,898			
Voluntown	37.5	17	656						
Wallingford	36.7	327				12,010			
Warren	27.1	13	350						
Washington	41.1	39	1,619						
Waterbury	28.2	3,252						91,715	
Waterford	36.9	107		3,935					
Watertown	28.6	212			6,050				
Westbrook	16.4	52	849						
West Hartford	21.4	414				8,854			
Weston	19.6	36	703						
Westport	20.8	246			5,114				
Wethersfield	13.1	331				4,342			
Willington	33.0	36	1,200						
Wilton	26.9	48	1,284						
Winchester	34.6	261			9,019				
Windham	24.1	573				13,801			
Windsor	29.5	191			5,620				
Windsor Locks	7.1	500				3,554			
Wolcott	20.2	36	719						
Woodbridge	19.5	60	1,170						
Woodbury	35.5	48	1,698						
Woodstock	59.1	30	1,767						
Total	4,820.0	[1] 286	87,800	74,571	148,853	209,384	175,531	240,364	444,128

[1] Average.

APPENDIX V.—POPULATION OF CONNECTICUT TOWNS—Continued

RECAPITULATION (ALL POPULATION GROUPS)

Group	Population per square mile	Number of towns	Percentage of total number of towns	Total population in group	Percentage of total population	Average population of towns
A	0–63	80	47.6	87,800	6.36	1,098
B	64–127	26	15.6	74,571	5.40	2,868
C	128–319	28	16.6	148,853	10.78	5,316
D	320–639	17	10.1	209,384	15.17	12,317
E	640–1,279	8	4.7	175,531	12.71	21,941
F	1,280–6,399	6	3.6	240,364	17.41	40,061
G	6,400 and more	3	1.8	444,128	32.17	148,043
Total		168	100.0	1,380,631	100.00	

APPENDIX V–A

INCREASE OR DECREASE IN POPULATION OF CONNECTICUT TOWNS FROM 1910 TO 1920 [1]

Town [2]	Ratio of 1920 population to 1910 population	Town [2]	Ratio of 1920 population to 1910 population	Town [2]	Ratio of 1920 population to 1910 population
Union	79.81	Monroe	115.86	Berlin	115.28
Hartland	82.35	North Branford	133.25	Windsor	134.51
Marlborough	100.33	Coventry	98.50	Cromwell	112.15
Warren	84.95	Bozrah	99.65	Plainfield	117.96
Canaan	79.91	Brookfield	81.38	Sprague	98.00
Colebrook	88.33	Madison	121.05	Bethel	84.41
Killingworth	83.48	Newtown	91.33	Watertown	157.14
Salem	95.71	Wilton	75.26	Southington	129.52
Ashford	100.74	Woodbury	91.29	Westport	120.07
Cornwall	82.09	New Hartford	83.06	Essex	102.55
Goshen	100.00	Sterling	98.67	Winchester	103.91
Voluntown	84.21	Westbrook	89.27	Hamden	147.19
Eastford	96.68	Lisbon	105.21	Stonington	111.81
Barkhamstead	83.12	Middlebury	127.63	Groton	142.06
Chaplin	88.50	Somers	101.20	Branford	109.59
Hampton	81.47	Mansfield	130.19	East Haven	196.12
Lyme	90.34	Woodbridge	134.02	Plymouth	118.34
Prospect	41.93	Brooklyn	89.07	Darien	106.03
Bethany	83.03	East Granby	132.49	Thomaston	113.02
New Fairfield	84.93	Guilford	93.40	Shelton	144.76
North Stonington	104.00	Ellington	106.40	Wallingford	107.66
Canterbury	103.22	Harwinton	140.27	Wethersfield	137.92
Scotland	82.14	Litchfield	105.82	Enfield	120.57
Kent	96.79	East Lyme	119.57	Fairfield	187.07
Sherman	93.67	East Hampton	100.18	Milford	233.46
Roxbury	77.29	Avon	114.73	West Hartford	184.15
Andover	104.85	South Windsor	95.15	Plainville	142.74
Hebron	102.35	Clinton	95.52	Putnam	113.96
Lebanon	87.89	New Milford	95.42	Seymour	141.68
Sharon	84.30	Ridgefield	86.81	Vernon	97.92
Bethlehem	97.45	Canton	93.30	Windsor Locks	95.66
Norfolk	79.75	Middlefield	101.06	Danbury	94.99
Oxford	97.84	Montville	121.64	Greenwich	134.38
Southbury	88.64	Old Saybrook	96.50	Middletown	106.65
Tolland	92.36	Bloomfield	131.46	Windham	109.49
Franklin	104.74	North Haven	87.31	Orange	147.39
Woodstock	95.56	Preston	143.08	Torrington	130.96
Bolton	103.47	Stafford	103.32	Stratford	216.15
Bridgewater	80.16	Cheshire	143.61	East Hartford	143.13
Ledyard	107.59	Suffield	105.96	Manchester	134.66
Morris	73.27	Simsbury	116.59	Bristol	152.71
Columbia	109.28	North Canaan	89.03	Naugatuck	118.30
Granby	97.03	Glastonbury	116.59	Stamford	138.94
Burlington	84.07	Waterford	127.05	Norwich	105.19
Pomfret	82.75	Chester	118.04	Norwalk	114.58
Weston	84.59	Thompson	105.23	Meriden	108.41
Willington	107.91	Trumbull	158.16	Derby	124.99
Wolcott	126.99	Rocky Hill	137.57	Ansonia	116.43
Old Lyme	80.10	Griswold	99.69	Waterbury	125.39
Washington	92.67	Portland	106.39	New Britain	121.40
Haddam	88.66	East Windsor	111.27	New London	130.66
Colchester	95.79	Farmington	110.52	New Haven	121.65
Easton	96.67	Saybrook	121.81	Bridgeport	140.66
Durham	96.18	Killingly	124.58	Hartford	139.55
Redding	81.32	New Canaan	106.21		
Salisbury	70.89	Newington	140.97		
East Haddam	95.45	Beacon Falls	137.32		

[1] Calculated from United States census, 1920.

[2] Towns arranged in ascending order of density of population

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APPENDIX VI

DISTRIBUTION OF MOTOR TRUCKS BY CAPACITY GROUPS AT SURVEY STATIONS

Survey station	Number of trucks per day	Distribution of motor trucks by capacity groups									
		½–1½ tons		2–2½ tons		3–4 tons		5–5½ tons		6–7½ tons	
		Number	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
1	138	104	74.9	18	13.2	10	7.6	6	4.1	----------	0.2
2	75	51	68.5	17	22.2	5	6.6	2	2.7	----------	----------
3	81	54	66.2	12	15.2	8	10.3	6	7.7	1	.6
4	75	54	71.0	7	9.7	8	10.7	5	7.8	1	.8
5	79	67	84.8	5	6.2	5	6.2	2	2.6	----------	.2
6	810	455	56.2	111	13.7	79	9.7	150	18.5	15	1.9
7	118	89	75.3	14	12.1	11	9.2	4	3.3	----------	.1
8	604	335	55.5	100	16.5	84	14.0	76	12.6	9	1.4
9	562	336	59.7	79	14.1	65	11.6	72	12.8	10	1.8
10	466	316	67.7	78	16.8	38	8.2	32	6.9	2	.4
11	322	155	48.1	58	18.0	46	14.4	58	17.9	5	1.6
12	530	378	71.2	64	12.1	39	7.4	45	8.6	4	.7
13	193	125	64.6	29	15.3	13	6.8	23	11.8	3	1.5
14	346	196	56.7	64	18.4	30	8.6	52	15.2	4	1.1
15	424	321	75.6	55	13.0	27	6.5	20	4.7	1	.2
16	118	93	78.7	14	11.5	6	5.3	5	4.2	----------	.3
17	66	41	62.3	14	21.3	5	8.4	5	7.1	1	.9
18	266	192	72.0	37	14.0	19	7.1	15	5.9	3	1.0
19	271	221	81.7	29	10.6	12	4.4	8	3.1	1	.2
20	247	171	69.1	40	16.2	23	9.3	13	5.2	----------	.2
21	192	138	71.6	27	14.2	17	9.0	9	4.7	1	.5
22	161	123	76.1	20	12.9	11	7.0	7	4.0	----------	----------
23	49	36	72.3	6	12.4	3	6.3	4	9.0	----------	----------
24	50	38	75.1	7	14.4	1	2.6	4	7.6	----------	.3
25	62	41	66.8	12	18.8	6	8.9	3	5.5	----------	----------
26	160	121	76.0	19	11.8	9	5.4	11	6.7	----------	.1
27	263	187	71.1	31	12.0	24	9.0	19	7.1	2	.8
28	104	59	56.6	17	16.8	8	8.0	16	15.4	4	3.2
29	138	101	73.5	19	13.8	8	5.6	7	5.0	3	2.1
30	166	116	70.0	24	14.3	9	5.7	15	8.8	2	1.2
31	91	67	73.5	12	13.5	6	6.8	5	5.0	1	1.2
32	92	66	71.9	14	14.9	8	8.8	4	4.4	----------	----------
33	180	140	77.6	20	11.3	10	5.8	9	5.0	1	.3
34	88	65	74.0	10	11.7	9	9.8	4	4.5	----------	----------
35	176	91	51.8	26	14.5	19	10.9	38	21.5	2	1.3
36	261	126	48.4	43	16.5	31	11.9	55	21.1	6	2.1
37	114	90	79.4	9	8.0	9	7.6	5	4.2	1	.8
38	354	185	52.3	56	15.8	44	12.3	61	17.4	8	2.2
39	129	82	63.7	17	12.9	10	8.2	17	13.3	3	1.9
40	271	169	62.4	32	11.7	26	9.6	39	14.3	5	2.0
41	220	132	59.9	23	10.7	16	7.4	47	21.0	2	1.0
42	246	156	63.2	34	13.9	19	7.9	35	14.4	2	.6
43	297	212	71.3	29	9.8	22	7.5	32	10.7	2	.7
44	230	173	75.2	21	9.0	22	9.8	13	5.6	1	.4
45	434	300	69.1	56	12.9	38	8.7	38	8.8	2	.5
46	269	141	52.4	44	16.4	29	10.6	53	19.7	2	.9
47	78	48	62.2	13	16.3	10	12.2	7	8.7	----------	.6
48	289	199	68.9	36	12.4	27	9.5	22	7.6	5	1.6
49	334	255	76.4	21	6.3	23	6.8	33	9.9	2	.6
50	330	223	67.5	35	10.7	30	9.2	37	11.2	5	1.4
51	88	61	69.3	9	10.8	10	10.9	7	7.9	1	1.1
52	115	71	61.3	13	11.5	13	11.6	14	11.8	4	3.8
53	278	167	60.0	27	9.8	30	10.8	47	17.0	7	2.4
54	117	76	65.1	15	12.7	11	9.5	12	10.1	3	2.6
55	114	90	78.7	9	8.2	9	7.7	6	5.4	----------	----------
56	214	116	54.4	33	15.3	26	12.2	34	15.9	5	2.2
57	59	50	84.7	5	8.1	2	3.6	2	3.6	----------	----------

APPENDIX VII

MOTOR-TRUCK CAPACITY OVERLOADS BY AMOUNT OF EXCESS LOAD

Amount of excess load (pounds)	Capacity (tons)															
	½		¾		1		1¼		1½		2		2½		3	
	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent
1-999	765	83.0	188	58.0	902	70.2	375	66.7	194	41.6	570	33.7	248	31.9	29	27.6
1,000-1,999	102	11.1	85	26.3	277	21.6	140	24.9	135	28.9	502	29.7	243	31.3	22	21.0
2,000-2,999	31	3.4	32	9.9	66	5.1	36	6.4	70	15.0	290	17.2	140	18.0	20	19.0
3,000-3,999	14	1.5	12	3.7	15	1.1	8	1.4	36	7.7	165	9.8	62	8.0	20	19.0
4,000-4,999	4	.4	4	1.2	10	.8	2	.4	23	4.9	65	3.8	51	6.6	9	8.6
5,000-5,999	4	.4	2	.6	5	.4	1	.2	3	.6	44	2.6	18	2.3	4	3.8
6,000-6,999			1	.3	5	.4			5	1.1	28	1.7	6	.8		
7,000-7,999					1	.1			1	.2	14	.8	3	.4	1	1.0
8,000-8,999	2	.2			1	.1					6	.4	4	.5		
9,000-9,999					2	.2					4	.2	2	.2		
10,000 and over											2	.1				
Total	922	100.0	324	100.0	1,284	100.0	562	100.0	467	100.0	1,690	100.0	777	100.0	105	100.0

Amount of excess load (pounds)	Capacity (tons)															
	3½		4		5		5½		6		6½		7½		All capacities	
	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent
1-999	334	25.0	8	14.8	669	23.6	27	36.5			42	51.2	4	44.5	4,355	41.4
1,000-1,999	290	21.7	19	35.2	789	27.9	23	31.0	3	60.0	15	18.3	3	33.3	2,648	25.2
2,000-2,999	228	17.1	12	22.2	578	20.4	10	13.5			9	11.0	2	22.2	1,524	14.5
3,000-3,999	212	15.9	9	16.6	365	12.9	5	6.7			10	12.2			933	8.9
4,000-4,999	119	8.9	2	3.7	188	6.6	6	8.1			3	3.7			486	4.6
5,000-5,999	78	5.8	2	3.7	94	3.3	1	1.4	1	20.0	1	1.2			258	2.4
6,000-6,999	32	2.4	1	1.9	54	1.9	1	1.4	1	20.0					134	1.3
7,000-7,999	21	1.6			34	1.2					2	2.4			77	.7
8,000-8,999	11	.8	1	1.9	44	1.6									69	.6
9,000-9,999	5	.4			15	.5									28	.3
10,000 and over	6	.4			2	.1	1	1.4							11	.1
Total	1,336	100.0	54	100.0	2,832	100.0	74	100.0	5	100.0	82	100.0	9	100.0	10,523	100.0

APPENDIX VIII

MOTOR-TRUCK GROSS WEIGHT OVERLOADS BY AMOUNT OF EXCESS LOAD

Amount of excess load (pounds)	Capacity (tons)															
	3½		4		5		5½		6		6½		7½		All capacities	
	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent	Trucks	Per cent
1-999	10	52.6			242	43.4	5	25.0	2	66.7	48	47.5	18	51.4	325	44.1
1,000-1,999	6	31.6	1	100.0	107	19.2	5	25.0			24	23.7	8	22.8	151	20.5
2,000-2,999	2	10.5			79	14.2	7	35.0			8	7.9	3	8.6	99	13.5
3,000-3,999					50	9.0	1	5.0			13	12.9	4	11.4	68	9.3
4,000-4,999	1	5.3			42	7.5	1	5.0	1	33.3	5	5.0	1	2.9	51	6.9
5,000-5,999					28	5.0							1	2.9	29	3.9
6,000-6,999					8	1.4					1	1.0			9	1.2
7,000-7,999											1	1.0			1	.1
8,000-8,999							1	5.0							1	.1
9,000-9,999					2	.3									2	.3
10,000 and over											1	1.0			1	.1
Total	19	100.0	1	100.0	558	100.0	20	100.0	3	100.0	101	100.0	35	100.0	737	100.0

APPENDIX IX

PERCENTAGE OF TOTAL GROSS WEIGHT ON REAR AXLE OF MOTOR TRUCKS

Motor truck capacity (tons)	Less than 50 per cent of capacity load		50 per cent to 100 per cent of capacity load		Over 100 per cent of capacity load		Maximum load [1]	
	Average gross weight	Portion of gross weight on rear axle	Average gross weight	Portion of gross weight on rear axle	Average gross weight	Portion of gross weight on rear axle	Gross weight	Portion of gross weight on rear axle
	Pounds	*Per cent*	*Pounds*	*Per cent*	*Pounds*	*Per cent*	*Pounds*	*Per cent*
½	2, 290	56. 3	2, 470	61. 9	4, 280	63. 8	9, 330	70. 2
¾	4, 510	55. 4	6, 040	60. 1	6, 460	64. 1	11, 500	68. 7
1	3, 260	63. 5	3, 670	68. 1	5, 380	74. 3	11, 600	75. 0
1¼	4, 460	55. 6	5, 410	61. 2	6, 560	66. 9	10, 320	71. 2
1½	5, 460	60. 3	7, 460	66. 2	9, 410	69. 7	13, 410	75. 5
2	7, 450	62. 3	9, 440	67. 3	11, 430	70. 1	21, 480	74. 0
2½	8, 450	63. 3	10, 470	67. 2	13, 420	72. 4	20, 450	77. 3
3	10, 370	62. 9	12, 500	63. 8	15, 400	68. 8	19, 360	67. 9
3½	12, 450	65. 9	14, 480	69. 3	18, 410	71. 6	25, 300	74. 9
4	12, 460	68. 5	16, 540	73. 2	19, 470	77. 4	22, 400	77. 7
5	15, 450	66. 3	20, 460	73. 4	23, 410	74. 4	30, 430	78. 0
5½	13, 500	65. 2	22, 540	74. 5	23, 510	76. 4	27, 270	74. 6
6½	18, 490	66. 0	24, 450	76. 4	25, 600	74. 5	29, 260	76. 7
7½	15, 280	60. 9	24, 430	73. 8	28, 650	72. 9	30, 400	80. 6

[1] Does not include extremely rare and infrequent loads.

APPENDIX X

AVERAGE LOADS ON TRUCKS EQUIPPED WITH VARIOUS TIRE TYPES

Truck capacity (tons)	Average net load (pounds)			Average gross load (pounds)		
	Type of tires			Type of tires		
	Pneumatic front and rear	Solid front and rear	Pneumatic front, solid rear	Pneumatic front and rear	Solid front and rear	Pneumatic front, solid rear
½	710	2, 340	1, 260	2, 940	6, 100	3, 720
¾	1, 020	3, 280	2, 830	5, 130	7, 840	7, 420
1	1, 380	2, 450	1, 960	4, 270	6, 360	4, 700
1¼	1, 540	3, 380	2, 490	5, 230	7, 900	6, 470
1½	1, 960	3, 050	2, 730	6, 830	8, 380	8, 070
2	2, 500	3, 820	3, 870	9, 100	10, 450	10, 230
2½	4, 160	4, 690	4, 740	11, 020	11, 640	11, 610
3	2, 970	4, 840	4, 650	10, 980	13, 250	12, 880
3½	4, 890	6, 160	5, 260	14, 350	15, 990	14, 930
4	5, 000	6, 890	6, 170	15, 000	17, 060	16, 140
5	6, 770	8, 660	9, 170	18, 130	20, 160	20, 580
5½	[1] 3, 150	8, 500	[2] 5, 920	[1] 15, 150	20, 450	[2] 17, 550
6½	8, 600	10, 210	9, 240	21 000	22 610	21, 650
7½	9, 500	9, 500	10, 230	22, 000	22, 190	21, 730

[1] Based on only two cases.

[2] Based on only four cases.

APPENDIX XI

TABLE A.—DISTRIBUTION OF TIRE THICKNESS AND WEIGHT PER INCH OF TIRE WIDTH, CHANNEL MEASUREMENT, REAR TIRES

TRUCKS WITH LESS-THAN-CAPACITY LOADS

Weight (pounds per inch width)	Total number of trucks	Number of trucks by groups of tire thickness in inches						
		0–0.4	0.5–0.9	1–1.4	1.5–1.9	2–2.4	2.5–2.9	3 and over
100	5			2		2	1	
200	70			7	12	21	16	14
300	498		2	44	148	172	105	27
400	772		3	77	277	226	145	44
500	693	1	1	62	238	218	130	43
600	459		3	15	130	177	122	12
700	231			15	78	87	43	8
800	62			6	23	20	11	2
900	17			1	4	9	3	
1,000	3					3		
1,100								
1,200								
Total	2,810	1	9	229	910	935	576	150
Per cent	100.0	0.1	0.3	8.1	32.4	33.3	20.5	5.3
Median weight (pounds per inch width)	460			431	458	472	466	427

TABLE B.—DISTRIBUTION OF TIRE THICKNESS AND WEIGHT PER INCH OF TIRE WIDTH, CHANNEL MEASUREMENT, REAR TIRES

LOADS IN EXCESS OF RATED CAPACITY

Weight (pounds per inch width)	Total number of trucks	Number of trucks by groups of tire thickness in inches						
		0–0.4	0.5–0.9	1–1.4	1.5–1.9	2–2.4	2.5–2.9	3 and over
100								
200	3			1	1			1
300	20			2	6	8	3	1
400	104			12	32	28	15	17
500	317		3	34	112	84	64	20
600	480	1	1	31	134	169	128	16
700	563			23	145	208	165	22
800	201			9	48	75	62	7
900	64			5	15	31	11	2
1,000	14				4	5	4	1
1,100	2				1	1		
1,200	2					1	1	
Total	1,770	1	4	117	498	610	453	87
Per cent	100.0	0.1	0.2	6.6	28.1	34.5	25.6	4.9
Median weight (pounds per inch width)	642			582	623	658	660	581

TABLE C.—DISTRIBUTION OF TIRE THICKNESS AND WEIGHT PER INCH OF TIRE WIDTH, CHANNEL MEASUREMENT, REAR TIRES

LOADS IN EXCESS OF 25,000 POUNDS GROSS WEIGHT

Weight (pounds per inch width)	Total number of trucks	Number of trucks by groups of tire thickness in inches						
		0–0.4	0.5–0.9	1–1.4	1.5–1.9	2–2.4	2.5–2.9	3 and over
100								
200								
300								
400								
500	3					2	1	
600	4					1	3	
700	64			3	4	27	25	5
800	46			1	5	20	19	1
900	20				3	9	8	
1,000	6				1	1	3	1
1,100								
1,200	1					1		
Total	144			4	13	61	59	7
Per cent	100.0			2.8	9.0	42.3	41.0	4.9
Median weight (pounds per inch width)	752					755	755	

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